NATURE

No. 4326 SATURDAY, SEPTEMBER 27, 1952 Vol. 170

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
J. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942

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MAN-POWER IN SCIENTIFIC RESEARCH AND DEVELOPMENT

THE tenth report of the Select Committee on Estimates for the Session 1951–52*, dealing with rearmament, covers several matters of special interest in connexion with scientific man-power. It will be recalled that the Estimates Committee for the 1946–47 Session, reviewing expenditure on research and development generally, made some recommendations for correcting certain weaknesses revealed by the inquiry, which had paid particular attention to the question of atomic energy. The Defence Research Policy Committee had then only recently been constituted; but the statement on the functions of that Committee and the note by the Ministry of Supply on research and development in atomic energy appended to that report were supplemented by the evidence which Sir Henry Tizard gave to the Select Committee. Afterwards, in evidence before the Estimates Committee for the 1948–49 Session, Sir Henry expressed the opinion that the Defence Research Policy Committee was a satisfactory co-ordinating body and one that would improve: it was working well and its influence had increased. He did not believe that there was then any unnecessary overlapping in research between the Ministry of Supply and the Admiralty.

This was the report in which the Estimates Committee was severely critical of the omission of details of expenditure on research and development from the Defence Budget and the Estimates, supporting the views of the Estimates Committee of 1946–47; and Sir Henry Tizard himself indicated that he would welcome the opportunity of being able to speak quite frankly to a special committee set up to satisfy Parliament in further detail as to expenditure on research and development. The Estimates Committee also announced in that report its intention of inquiring further into the matter. The present report, however, does not pursue the question of expenditure directly, although its inquiry into man-power problems, and particularly into scientific staff and into the design and research establishments, bears closely on the implied question, which is even more important to-day when research and development work desired by the Services can only be undertaken at the expense of resources equally needed for productive purposes in Britain's economic recovery.

The Estimates Committee of 1946–47 noted that the principal needs were for men and accommodation. These, rather than lack of money, were holding up the pursuit of profitable lines of research. In the present report, the Committee finds that, apart from some difficulty in obtaining skilled labour, the man-power situation is reasonably satisfactory in both factories and research establishments engaged on the rearmament programme, except in regard to the call-up of apprentices and the supply of scientific staffs in government establishments. The Committee

* Tenth Report of the Select Committee on Estimates, 1951–52. Rearmament. Pp. xi+148. (London: H.M.S.O., 1952.) 6s. net.

is not entirely satisfied with the present method of the call-up of apprentices, and it makes two specific recommendations. First, it recommends that apprentices should never be called up until their apprenticeship is completed. Secondly, it suggests the creation of some form of technical reserve, similar in its nature to the railway companies of the Royal Engineers, in which skilled men who have served their apprenticeship should carry out their military service. The Radio Industry Council suggested in evidence that the call-up of professional engineers and technicians should be limited to five months, followed by service in the Territorial Army for five and a half instead of four years.

It could fairly be deduced from the minutes of evidence taken before the Committee that its tenth report does not refer more specifically to expenditure on defence because the security curtain is used by officials to avoid pertinent questions. Sir Ralph Glyn's remark on another occasion : "There has been more extravagance in expenditure due to documents being labelled 'Secret' than from any other single cause. . . . The word secret is very often applied in order to cover up extravagance", is worth remembering. It is the more imperative, therefore, to ensure that every possible means of avoiding waste of trained man-power should be examined, and no excuse of administrative inconvenience can be accepted as reason for not exploring such suggestions.

The second matter, that of the shortage of scientific staff, particularly in the lower grades, which is due to some extent to the higher salaries which young men can obtain in industry or in posts overseas than in the government service, with consequent turnover of staff, deserves more consideration, and the minutes of evidence on this point are of considerable interest. When the Estimates Committee of 1946–47 reported that the new salary scales proposed for the Scientific Civil Service, and the ability to transfer pension rights, coupled with the conditions of service, offered a reasonable prospect of attracting sufficient scientific staff of the requisite calibre, Dr. Cockcroft, as he then was, expressed himself as satisfied with the scales in general although higher salaries were paid in industry. In the interim, those salary scales have fallen further behind those existing elsewhere, and evidence supplied to the 1951–52 Committee plainly shows that responsible and highly trained scientific men employed in posts requiring exceptional ability are seriously underpaid in relation to the importance and responsibility of their work and of their capacities, and in relation to the exceedingly costly capital equipment for which they are responsible.

It was stated, for example, that the Department of the Controller of Guided Weapons and Electronics, Ministry of Supply, is experiencing difficulty in recruiting sufficient scientific workers, as opposed to mechanical, electrical and electronic engineers, to meet the Services' requirements in research and development. At the National Aeronautical Establishment at Bedford, difficulty is expected in obtaining sufficient technical staff due to Government policy in regard to staffing. Vacillation in the policy of staff recruitment was regarded as very detrimental to the recruitment of the best possible men.

Subject to that reservation, the Select Committee on its visit to Bedford found no doubts as to the ability of that establishment to attain the high intellectual standard characterizing the Royal Aircraft Establishment staff at Farnborough. It was emphasized that, although the scientific man is naturally concerned to some extent about salary, he attaches great importance to the provision of first-class facilities for carrying out his research. Accordingly, many men who could command salaries in industry as much as double those they receive in the government service choose to remain because of the excellent facilities they are afforded. Apart from equipment, the aim is to provide the intellectual freedom that is necessary, and in the main, Prof. A. A. Hall, director of the Royal Aircraft Establishment, claims that the effort has been successful.

The evidence given before the Select Committee casts some doubts on Lord Cherwell's contention in the House of Lords before he took office that an alternative form of organization outside the Civil Service would offer some advantage in dealing with developments like atomic energy, and particularly such an establishment as Harwell. Conditions there, as evidence submitted to the Select Committee makes plain, differ from elsewhere. At Bedford, the turnover of scientific staff was estimated as about five per cent per annum. The corresponding figure for Harwell appears to be about ten per cent ; but although the university aspect of that establishment was stressed in evidence before the Committee and in a memorandum submitted by the Ministry of Supply, the wastage of scientific officers from other atomic energy establishments is no higher than that from other defence research establishments, and that from Harwell amounted to no more than twenty-four officers a year in 1950 and 1951. Harwell, in fact, has been regarded as something in the nature of a technical university. Its unique facilities for training workers in the problems and techniques of nuclear research naturally attract to it a number of young men who look upon it as a necessary stepping-stone in their selected career of scientific work.

Nevertheless, the wastage of staff at Harwell is only comparable with the output of postgraduate students from a university, and the attraction of working at least for a period in a novel field under a scientist with a world-wide reputation to some extent offsets the inability to offer exceptional salary scales to attract outstanding men, but which it would be difficult to justify within the Scientific Civil Service. The staffing position for the atomic energy projects does not at present cause undue disquiet ; but equally the Ministry of Supply admits that it is not a matter to be viewed with complacency. On this point the Select Committee, which is satisfied that the equipment in government research establishments is of the highest quality and that it is important to ensure that the men recruited to use this equipment are of like quality, recommends that the scales of salary and conditions of employment should be kept under constant review.

This is only common prudence, in order to secure the full return from the large sums of public money already allocated to schemes of scientific research and development; but although there is welcome evidence in this report that the importance of conditions of service and of securing contented teams of skilled staff are more widely appreciated than when the Barlow Committee reported, there is evidence also of waste through neglect of this consideration. The Committee refers, for example, to the probability that the proposed transfer of the Fighting Vehicles Design Establishment to a fresh site will involve not only a large waste of public money but also the break-up of a valuable team of scientific experts.

The Select Committee fully recognizes the difficulties which may sometimes be encountered in avoiding costly decisions of this type. The risk, too, that expensive constructional work may be rendered out of date by scientific discoveries made before the work has even been completed cannot always be excluded. Apart from the secrecy issue already mentioned, the Select Committee's report is on the whole reassuring, and even where the secrecy curtain was most baffling, it appears to be satisfied that the money spent on the atomic energy project is justified by the results so far achieved. Nevertheless, the warnings given in this report are plain enough, and sufficient material should now be available for scientific men to make sure by their professional action that the position does not deteriorate.

Some other points in this report merit notice. Evidence was submitted of the need for greater attention to the function of the technical colleges in providing technicians—a function commonly ignored in discussions on technological education. It was estimated, however, that only some 1,750 technicians would be required for research and development in the rearmament programme, instead of the 3,000 estimated by the Hankey Committee.

Sir John Cockcroft's evidence before the Committee is of special interest. He estimated that about one-third of the effort at Harwell could be broadly described as research and the remainder as development, including about 15 per cent on the production of isotopes. The demand for these is rapidly increasing, and it has since been announced that Great Britain is now the world's largest exporter. Sir John also expressed the opinion that the numbers and quality of staff recruited for atomic energy work are satisfactory, although it is the younger men rather than the older who are being attracted. He was not disturbed at a wastage of scientific staff running to ten per cent. What is disturbing, however, is the reference elsewhere in the evidence before the Committee to a drift of highly qualified men of science from Britain to America, attracted by the much higher salaries offered there.

This loss is not great at the moment: it was put at about fifty last year; but the loss of even that number of our best brains is nevertheless a serious tax on our limited resources of scientific and technical man-power, and the evidence of the Controller of Atomic Energy on the disparity of salaries in Britain and overseas is not reassuring in this connexion. The Ministry of Supply's evidence on scientific staffing admitted that the scientific man entering the government service is probably underpaid in comparison with industry—as is also the scientist at the top of an establishment; it is contended, nevertheless, that the men in the middle range compare favourably in salary and conditions with those elsewhere. Sir Frederick Morgan, however, was prepared to argue a case for special scales for those on atomic energy work. He maintained that the man who is capable of original thought and of reducing it in a disciplined way into something which is handed over later to the production side is invariably on a scale of wages which bears no relation to the value of the work he is doing.

This report clearly emphasizes the danger of failing to get full returns from Britain's huge expenditure on research equipment through parsimony in the conditions offered to the men who use that equipment; nevertheless, it will fully justify the Committee's careful inquiries. No less important, however, is its warning of the dangers which also attend the use of the cloak of secrecy to hamper Parliamentary scrutiny of expenditure on research and development. Public scrutiny remains the surest safeguard against either extravagance or duplication of effort, and other evidence of Sir Frederick Morgan rather offsets Sir Henry Tizard's confidence as to the effectiveness of the Defence Research Policy Committee in this regard. His evidence led the Select Committee to correct its earlier impression that that Committee and the Advisory Council on Scientific Policy covered the whole field of research and development. In a strictly formal sense, atomic energy stands apart from the field covered by those two committees, and the complicated position disclosed by the evidence set forth in this report suggests that the position is not entirely satisfactory. Something more appears to be required in the way of co-ordination, even informally, before the organization of Britain's research and development effort can be regarded as adequate. The experience which Sir John Cockcroft brings from the atomic energy field to his new responsibilities as chairman of the Defence Research Policy Committee and of the Advisory Council on Scientific Policy should be a real help; but the need for fresh constructive thought here is as plain as is the need for limiting the use of the security curtain to the minimum consistent with national safety.

LOGICAL FOUNDATIONS OF PROBABILITY

Logical Foundations of Probability
By Rudolf Carnap. Pp. xvii+607. (London: Routledge and Kegan Paul, Ltd., 1951.) 42*s*. net.

PROF. R. CARNAP is one of the leaders in the modern school of mathematical logic. Perhaps his most striking contribution is his emphasis on the distinction between language and semantics (the theory of the meanings of the expressions in language). For example, Whitehead and Russell are said to have

defined the number of a class as the class of all classes cardinally similar to the given class. (At least, this is the usual description of what they did; their actual procedure was more elaborate.) This is one interpretation of number. If it is supposed to be the only one, an ordinary mathematician appears to be precluded from using 'number' to mean anything else, even though other things may appear to follow the same rules. The modern method would be to consider a language containing the signs for the numbers—rules for manipulating the signs are stated in a further language called the metalanguage—and in this way a formal development of mathematics is created. The legitimacy of the interpretation of the signs and operations in a particular way becomes a separate problem. This idea can be applied to logical systems at the most elementary levels, and has led Carnap and others to considerable clarification of the foundations of logic.

The main theme of the present book is the application of this method to probability theory. Carnap distinguishes between two kinds of probability, which he denotes by probability$_1$ and probability$_2$. Both satisfy the same rules of manipulation. Probability$_1$ is regarded as a logical relation between pairs of statements expressible in a given language; probability$_2$ as a limiting relative frequency in an infinite series of experiments. An adequate account of scientific inference must include both. The discussions are very full on both the symbolic and the interpretative levels.

One difficulty of the subject is the distinction between 'subjective' and 'objective'. I have gone so far myself as to say that both words have been used in so many different senses that they should be abandoned as *nomina confusa*. Carnap's method enables him to say that both kinds of probability are objective. For probability$_1$, his argument permits him to avoid the term 'degree of rational belief', on grounds similar to those given by Russell for deductive logic. Russell argued that $2 + 2 = 4$ is a logical relation between sets of classes and has nothing to do with the existence of a mind, rational or not, to appreciate it. The ability of a mind to understand and use it belongs to the interpretative level. Similarly, Carnap would regard probability$_1$ as a ratio of measures of sets of sentences and call it a 'degree of confirmation'; this is *used* in rational belief but is not its whole content. This seems to add some clarity. However, as he himself points out, the measures can be taken in many ways; his theory gives rules that must be satisfied by any system of probability$_1$, but many different numerical assessments would satisfy the rules, and the decisions between them need further discussion on the interpretative level. Most of the argument is quite general, and many controversial questions are well discussed.

Carnap discusses one particular assessment, which appears to be equivalent to Laplace's principle of indifference, and remarks that in some circumstances this leads to contradictions. A second volume is in preparation and will apparently produce more specific results. Some of these are described in an appendix, which states a modification of the principle of indifference to avoid contradictions. This seems similar to the rule that I have stated for the sampling of a population with respect to more than two exclusive properties. I doubt, however, whether this can cover the ground. Carnap does not appear to mind the conclusion (given by Laplace's form) that the initial probability of a general law, applied to an infinite class, is zero; and there is something to be said for that view. But Laplace's form also leads to the conclusion that if an event has succeeded in l trials and failed in none, the probability that it will succeed in all the next $l + 1$ trials is $\frac{1}{2}$, and this seems definitely too low to correspond to scientific practice. The modified rule appears to intensify this difficulty. I hope that Carnap will attend to this point, because I know of nobody better equipped to produce a satisfactory solution.

The book has not much to say about probability$_2$, except that values of probability$_1$ are often estimates of probability$_2$. I am inclined myself to think that the idea of an intrinsic probability is useful, though I think that the attempt to define it in terms of a limiting frequency creates more difficulties than it solves, and I cannot see that anything in the book depends on the definition. It might be argued that the only cases of probability$_2$ are in quantum physics; one, for example, would be the probability that a radium atom will disintegrate in the next minute. In coin-tossing, we might make a definition in terms of a limiting frequency (assuming it to exist) for a sequence of throws with one coin (assuming that the coin never wears out), or in terms of one throw each for an infinite set of coins (again assuming the limit to exist). But there is no way of proving that the two definitions would give the same assessment, without piling up further assumptions that appear no more plausible than the notion of an intrinsic probability seems to begin with.

The book is far the best analysis of the logic of probability that has yet appeared, and will be indispensable to students of the subject. The specific applications announced for the second volume will be awaited with interest. Harold Jeffreys

ORGANIC CHEMISTS' VADE-MECUM

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 1, Part *A*: General Introduction and Aliphatic Compounds. Pp. xxiii+778. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) £7.

THE hiatus existing between the necessarily highly selective and simplified text-book treatment of organic chemistry and the comprehensive scope of compendia such as "Beilstein" has for long been filled by Richter's "Chemistry of Carbon Compounds". The last edition in English of this work appeared thirteen years ago, and even this was a patchwork overhauling of an earlier version. The need for a successor has been markedly apparent, and the onus of this task has been accepted by the Elsevier Publishing Co. in consultation with an advisory committee of six distinguished British organic chemists headed by Sir Robert Robinson; the herculean task of editorship is being shouldered by Dr. E. H. Rodd. The present book represents the first stage in the compilation of a five-volume work to take the place of "Richter" in providing a modern comprehensive treatise on organic chemistry.

The book opens with an editorial historical survey and sections on the classification, nomenclature and

literature of the subject. There follows a description of the quantitative analysis of organic compounds; as this is written by a practitioner of the art, Mr. R. Belcher, there is a welcome absence of description of the obsolescent apparatus and procedures beloved of many other text-books. The striking infiltration of physico-chemical ideas and techniques into organic chemistry is reflected in the contents of the next two hundred pages, which are devoted to an exposition of the underlying theory of the science. This subject has been handled by the allotment of a section to every important topic, each being dealt with in essay form by an expert in that field. Thus the discussion of free radicals and homolytic reactions is in the hands of Prof. D. H. Hey and Dr. W. A. Waters, stereochemistry is expounded by Prof. E. E. Turner, and the crystallography of carbon compounds is described by Dr. A. F. Wells. A review of the physical properties used in the investigation of organic compounds is given by Prof. H. D. Springall, who also deals with modern concepts of acids and bases in their relation to organic chemistry. The section on light absorption, by Dr. E. A. Braude, is a succinct account of the theory and practice of ultra-violet and infra-red spectroscopy and includes useful charts of the characteristic infra-red frequencies associated with a large number of organic groupings. An authoritative article on reaction mechanisms, by Prof. E. D. Hughes, contains the gist of the modern work on the subject, written as it is by one who has made large contributions to this study. Very little reference is made, however, to the alternative view of anionotropy as an essentially acid-catalysed process; it is surely a little ungenerous to dismiss this considerable body of carefully executed work in a two-line footnote. Owing to the unavoidable compression of this wide topic, the full benefit of this section will accrue to those who already have some acquaintance with the subject.

No attempt has been made to include a detailed account of the twin concepts of valence bond and molecular orbital treatment as applied to organic compounds, beyond a brief description in the historical section. This is a sensible decision; the subject does not lend itself easily to compression, and the recent publication of Prof. C. A. Coulson's monograph on this topic renders any such treatment redundant.

The remainder of the book is taken up with its primary task of systematically presenting the known facts of aliphatic chemistry. The exposition deals with hydrocarbons and their halogen derivatives, alcohols and their sulphur derivatives, amines, organo-metallic compounds, carbonyl compounds, carboxylic acids, glycols, hydroxycarbonyl and dicarbonyl compounds; the remaining aliphatic types will be dealt with in Vol. 1 *B*. Sound arguments for retaining this Richter classification are presented in the preface, and indeed no difficulty is experienced in finding any required section.

This enormous mass of information is laid out in a lucid and concise manner, clarity being greatly enhanced by the extensive use of tabulation. The exposition succeeds admirably in its aim of rendering easily available the accumulated knowledge of organic chemistry; a striking feature is the wealth of up-to-date leading references both to the original literature and to review articles. Ease of reference is greatly enhanced by the provision of a truly magnificent index, for which grateful tribute must be paid to the editor.

The production of the volume is of the excellence one has come to expect from Elsevier, and the book is a pleasure to handle. The errors are surprisingly few for a work of this range, and such as do occur in the text are typographical trivialities. It is unfortunate, however, that the first entry of tropolone into a text-book should be heralded by a sadly malformed structural formula. The price of the book is not excessive in view of its content, and a 15 per cent reduction is allowed both for this and the following volumes if they are ordered prior to publication. The debt already owed by organic chemists to these publishers for their very fine encyclopædia is further increased by their presentation of this authoritative work.

CONVEYING OF HEAT ENERGY

Elements of Heat Transfer and Insulation

By Prof. Max Jakob and Prof. George A. Hawkins. Second edition. Pp. xvi+230. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 32*s*. net.

IN the preface to this second edition of their book, the authors remind us once more that the subject of conveying heat energy is not of less importance than that of converting it. Many would consider this an under-statement, for not only do heat transfer problems confront the practising engineer more frequently than thermodynamic ones in many fields, but also their solution is more difficult and often requires an intuition of what aspects are vital and what may be neglected, which only experience based on theoretical understanding can provide. However, in universities it is not yet usual to accord the teaching of heat transfer equal status with that of thermodynamics, partly no doubt because the former subject is comparatively new, but partly because of the lack of suitable text-books for undergraduates. Profs. M. Jakob and G. A. Hawkins have set out to make good the lack.

As usual, they divide heat transfer into three parts—conduction, convection and radiation—although they do have chapters dealing with the combined effects of all three modes. The main emphasis is on the first of these, and there are excellent simple accounts of the application of relaxation and graphical methods to those problems in heat conduction, both steady and unsteady, which are too difficult for mathematical analysis. Although these matters are often considered 'advanced', the clarity with which they are presented brings them well within reach of the undergraduate. A large amount of useful data on thermal conductivities is provided.

The treatment of convective heat transfer is more sketchy. Despite the authors' statement that forced convection is probably the most important method of heat transfer, only five pages are devoted to it, and these contain little more than a bald presentation of the empirical relations between the dimensionless groups for flow inside and outside tubes.

The dimensionless groups are derived by the algebraic method. This has the disadvantage that their physical significance is not apparent, a disadvantage, however, which appertains not to dimensional analysis, as the authors assert, but to the algebraic presentation of it. Many students find more

illuminating the alternative derivation of, say, the Reynolds number as the ratio of inertia to viscous forces, and of the Grashof number as the ratio of buoyancy to viscous forces.

The authors suggest that the theory of convective heat transfer based on the surface film concept of Langmuir and Rice is more "conspicuous". Yet this theory leaves unanswered the question of why such a film occurs, and how its properties must vary with the conditions of flow. It seems a pity, therefore, that space was not found for introducing the idea of a thermal boundary-layer and the heat-balance equation which determines its thickness. On the other hand, the authors have presented Reynolds's analogy between friction and heat transfer in a rather more detailed manner than usual; I feel that this thoroughness is not worth the resulting loss of clarity. The analogy is chiefly useful for rough but speedy calculations; when greater accuracy is needed, it is usually possible and preferable to turn to experimental results or more exact theory rather than to elaborations of the analogy.

The book contains a concise account of radiant heat-exchange between black and grey bodies; but gases and flames are not treated. The emphasis is on providing useful design data rather than the underlying fundamental relations. There is a short chapter on heat transfer in boiling and condensation, but mass transfer is dismissed in a sentence.

D. B. Spalding

TEXT-BOOK OF PLANT GROWTH SUBSTANCES

Die Wuchsstofflehre

Ergebnisse und Probleme der Wuchsstofforschung. Von Prof. Hans Söding. Pp. xi+304. (Stuttgart: Georg Thieme, 1952.) 33 D. marks.

PROF. HANS SÖDING says that his aim in writing this book is to make a comprehensive presentation of all aspects of research on growth substances, set in their proper perspective in the wider field of plant physiology. To achieve this, he assumes the usual text-book knowledge of plant physiology; but where this is not sufficient to allow a clear exposition of his thesis, he touches on wider physiological problems. In addition to presenting results of published work (as far as 1949, with a few additions for 1950–51), he has attempted to indicate open questions and avenues for further exploration. In this he succeeds admirably.

The first two chapters are concerned with accounts of assay and extraction methods, including full details of Prof. Söding's own 'daylight curvature test', with data on magnitude of response and variability. Such data are useful for comparison with other methods of hormone assay.

Chapters on the distribution of growth substances in plants during development, the role of external and internal environment, auxin transport, tropisms, the role of auxin in cell division, root formation, etc., and the mechanism of auxin action, follow patterns similar to those in existing works in English on these topics. They are useful, however, for the inclusion of much recent Continental work, especially war-time German research, the original reports of which are not always readily available in English libraries.

To appreciate the chapters on extraction of auxins from plants and on the chemistry of growth-promoting and -inhibiting substances, some remarks on nomenclature are necessary. The term 'growth substance' (*Wuchsstoff*) is defined as meaning substances (including synthetic compounds) which increase extension growth of higher plants, especially the oat coleoptile. Naturally occurring growth substances are considered to be auxins *a* and *b*, with 3-indolylacetic acid (heteroauxin) acting probably as an activator of these substances in the plant. For the benefit of Continental readers, Prof. Söding points out that in the English literature the term 'auxin' denotes not auxin *a* or *b* but any of a range of natural and synthetic growth substances, depending on the context, though usually it refers to heteroauxin.

That such explanations should be necessary emphasizes present-day confusion resulting from indecision on the nature of growth hormones in plants. The question whether these are auxins *a* and *b*, or 3-indolylacetic acid and related compounds, is still *sub judice*. It must be admitted, however, that with the passage of time convincing evidence in favour of the existence of auxins *a* and *b* in higher plants becomes more slender, while proof (for example, by chemical identification and by enzymatic studies) of the importance of certain indole compounds as natural growth hormones increases. Much of the evidence for the existence of auxins *a* and *b* is based on acid- and alkali-stability tests on plant extracts (examples are listed on p. 74), and this will now need re-examining in the light of the recent discovery of 3-indolylacetonitrile as a naturally occurring growth hormone.

The fact that indolylacetic acid can be extracted from many plant tissues, regarded by the majority of British and American workers as strong evidence of the importance of this substance as a naturally occurring growth hormone, is considered by Prof. Söding to be the greatest weakness of extraction methods. He believes that indolylacetic acid belongs primarily to the protein metabolic cycle and not to the auxin cycle (p. 87), and that deductions about the growing system cannot be made with certainty from extraction data (p. 23). This approach would seem to rule out the possibility of further experimental advance on the chemical side and to make the question of the identity of the natural auxins one which should not be asked.

Possibly the most valuable sections of the book for the English-speaking reader are those on the role of auxins in correlative inhibition, polarity of regeneration and other aspects of morphogenesis, since these topics, which have been developed so extensively by German workers, tend to be neglected in British and American text-books.

There are two useful chapters on the position occupied by growth substances in the hierarchy of plant hormones and vitamins (*Wirkstoffe*), and the interactions of these substances in the plant.

In the concluding *Ausblick* the future development of hormone research is discussed. With the increasing tendency to rely on the interpretation of mathematical curves and figures, the subject becomes ever more *vergeistigt*; but Prof. Söding hopes that the biologist of the future will see behind his figures the same beautiful and harmonious picture of Nature as the Nature-lover sees in the butterfly and the flower.

The book is expensive in British money, but is well produced, and would be a useful addition on plant hormones to any library. J. A. Bentley

Breeding Birds of Kashmir

By Lieut.-Colonel R. S. P. Bates and E. H. N. Lowther. Pp. xxiii+367+85 plates. (London: Oxford University Press, 1952.) 38*s*. net.

BEFORE the Second World War, Kashmir was a favourite resort of Europeans desirous of a change from the heat of the plains to a cooler climate, wonderful scenery, beautiful flowers, and a great variety of birds. The authors are experienced field naturalists who have made a speciality in photographing birds in India and, in addition to making many studies in the plains, have devoted much time to Kashmir birds. The country they worked in lies between the great Himalayan range and the Pir Panjal range and is drained by the Rivers Jhelum and Kishenganga and the upper waters of the Wardwan River. The whole area consists of valleys with orchards, lakes and marshes, and, on the hillsides, forests with bare screes above and upland meadows in the higher reaches.

With this great variety of habitats there is a corresponding variety of bird life. In the lower parts of the valleys there are a few oriental species from the plains of India, such as the magpie robin and the jungle babbler. Higher up there are the grey drongo and slaty-headed parakeet, both Himalayan species. Another plains bird is the pheasant-tailed jacana, which is migratory and in the summer abounds among the lotus leaves of the numerous lakes; according to the authors, one was seen on a tarn at 12,050 ft., but they give no date. Of the palæarctic birds some are residents; but the majority descend to the Indian plains with the advent of autumn, while others do not go farther than the foothills of the Himalayas.

The volume is confined to the birds breeding in the area mentioned, and many species recorded as nesting in Kashmir are not included since they resort to the more bleak areas of Ladakh and Baltistan to breed. The habits and nests of 116 species are described, and when the authors have not sufficient experience they amplify their notes with extracts from the writings of other ornithologists.

This is a very interesting book, with a certain amount of new information which does not always agree with the accounts in Baker's "Identification of Indian Birds". There are eighty photographs of nests, birds and scenery, most of which are of a high standard, but this can scarcely be said of the coloured plates—the birds are stiff, and the colours have suffered in reproduction.

Études sur les scorpions

Par Max Vachon. Pp. 482. (Alger: Institut Pasteur d'Algerie, 1952.) 2200 francs.

THE determination of scorpions has for years been a puzzling task, because of the variation which many species show. For this reason M. Vachon has undertaken an intensive study of the scorpion fauna of North Africa, with a revision of their systematics and nomenclature.

He now offers us, first, a general account of the order, taken largely from his chapter in Grassé's "Traité de Zoologie", which will be welcomed by many who do not possess that expensive work. Secondly, he reviews the characters that can be successfully used in identifying a scorpion, emphasizing chiefly the trichobothria or *poils auditifs* on the appendages. There follow descriptions of the thirty-three species of North African scorpions which M. Vachon recognizes, with dichotomic tables summarizing the whole. It is a feature of these keys that they can often be used for mutilated specimens. M. Vachon has no hesitation in adopting a trinomial system for the many subspecies he establishes, nor to extend this by the addition of varietal names for forms which are often distinctive for special localities.

M. Vachon has included an account of the geographical distribution of these animals, and a discussion of their origin and dispersal. His book may be recommended as an impressive example of a truly biological survey of a limited group, almost a model for others engaged in similar work.

T. H. SAVORY

Mellor's Modern Inorganic Chemistry

Revised and edited by Dr. G. D. Parkes. Pp. xxi+967. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 25*s*. net.

THIS well-known text-book was revised and rearranged in 1939 by the late Prof. J. W. Mellor in collaboration with Dr. D. G. Parkes. Since then it has been several times reprinted; for this present edition the text has been once again reset. Up-to-date matter inserted here and there throughout the book accounts for thirty new pages. In addition, there is a new chapter (nine pages) summarizing the chemistry of the metals.

According to the preface of 1939, a guiding principle of the editors was the keeping of "a proper balance between theory and facts". However, revision of the theory is not of the same high level as that of the factual material. Resonance gets a paragraph in small print; the covalent and co-ordinate links get less than two pages of small print, and not one of these is sufficiently deeply expounded to make it readily applied. Thus in discussing boron fluoride, Dr. Parkes is not able to relate its structure and its intense activity. All the periodic tables end with uranium. The Brönsted-Lowry conception of acids is not mentioned.

Apart from these points, the revision has been well done, and the book retains those qualities which gained for it its high reputation.

G. F.

Sedimentary Petrography

With Special Reference to Petrographic Methods of Correlation of Strata, Petroleum Technology and other Economic Applications of Geology. By Henry B. Milner. Third edition, reprinted with a new Preface and Corrigenda. Pp. xix+666+52 plates. (London: Thomas Murby and Co., 1952.) 50*s*. net.

MILNER'S "Sedimentary Petrography" has been in use for many years as a text-book and standard work of reference in British universities. The second (first complete) edition was published as long ago as 1929, and an enlarged and completely revised third edition appeared in 1940. This has been out of print for some years and has now been reprinted. It is issued unchanged except for a page of corrigenda and a corrected and revised list of the British Standards quoted in the book. It is to be regretted, in view of the large amount of research carried out on the sediments in the past decade, that pressure of work has not permitted the author to complete the revised fourth edition that he has in hand. Nevertheless, the ground covered in the work as it stands is so comprehensive, including both descriptive matter and laboratory technique, that it will doubtless continue to provide a valuable introduction to the subject for university students.

NUCLEAR AND FUNDAMENTAL PARTICLE PHYSICS

At the summer provincial meeting of the Physical Society, which took place in the Department of Natural Philosophy, University of Glasgow, during July 10–11, four main sessions were held and five main topics were considered from both the experimental and theoretical points of view. The president of the Society, Prof. R. Whiddington, was in the chair. The opening session dealt with the excited states of light nuclei, and in the afternoon the subject of π^0-mesons was discussed. On the morning of July 11 the chief topics were β-radioactivity and photo-disintegration, and in the afternoon a theoretical session on the *S*-matrix series was held. Discussion followed each session. The general opinion of all those participating was that the conference had proved very profitable indeed, and it had been a fitting occasion on which to use, for the first time, the new lecture theatre in the extension to the Department.

Excited States of Light Nuclei

Prof. P. I. Dee (Glasgow), in reviewing existing knowledge of excited states of nuclei, indicated the need for some principle correlating nuclear data. He illustrated in an original manner the severely limited field covered by most of the known methods for determining nuclear levels, which methods include neutron absorption, proton capture, β- and γ-activity, scattering, and the different particle reactions such as (*d*, *p*), (*d*, *n*), (*d*, α), (*p*, α) and (α, *p*). Detailed discussion of the measurement of γ-ray energy and the kinetic energy of particles was followed by consideration of resonance excitation. The absence of internal conversion has led to indirect methods of determining quantum energy; but accuracy is reduced ($\sim 0{\cdot}1$ MeV.). However, the situation is improving with the introduction of scintillation counters. For particle energies a large magnetic spectrometer is the most accurate (errors $\sim 0{\cdot}005$–$0{\cdot}01$ MeV.), but the low efficiency limits its application. Nuclear photo-emulsions offer a good solution, as shown by work at Bristol and Liverpool.

Regarding data on spin and parity, Prof. Dee considered that the methods are too tentative to be really satisfactory. The study of angular distributions is fruitful, and the method of internal pair creation, as used at Glasgow, seems to be of fairly wide application. It is his belief that as few as 10–20 states are known with complete certainty, and a brief review of the efforts to find regularities in the arrangement of levels leads to the conclusion that these are, at best, hopeful. A determined effort on the theoretical side, therefore, seems overdue.

Dr. J. G. Rutherglen (Glasgow) discussed mainly the resonances for the processes ^{27}Al (*p*, α) ^{24}Mg and ^{27}Al (*p*, γ) ^{28}Si, showing that three out of six observed are common, involving competition. In considering internal pair creation, as applied by Dr. E. R. Rae and himself to the study of γ-ray states, Dr. Rutherglen said that the low values of *I*, the internal pair coefficient ($\sim 10^{-3}$), necessitate considerable care in estimating the number of positrons emitted. The estimation can be made with the magnetic spectrograph or by measuring the annihilation quanta produced on stopping the positrons. Tests with sodium-24 are in agreement with other methods, which show the transitions are electric quadrupole. A new method of estimating the absolute number of γ-rays by measuring the area under the spectrum of Compton secondaries has been found useful when no β-rays are emitted, and the method has operated successfully for capture of γ-radiation (protons on fluorine).

The next speaker, Prof. H. W. B. Skinner (Liverpool), discussed stripping reactions using 8-MeV. deuterons, and showed how this has become a very powerful method, of wide applicability, for finding the spins and parities of nuclear states. Early work with photo-plates yielded valuable data but involved considerable labour in the analysis. More recently, differential ion chambers and proportional counters have operated successfully with (*d*, *p*) reactions, and moreover permit examination down to any small angle relative to the beam. Both (*d*, *p*) and (*d*, *n*) reactions have been assumed to proceed by way of a compound nucleus, but results, particularly at small angles, contradict the early theory and suggest a stripping mechanism. Comparison of angular distributions with the theoretical predictions (based on theoretical studies at Birmingham and Liverpool) show that spins and parities of states can be reliably deduced. Prof. Skinner illustrated the technique with many interesting examples, directing particular attention to the finding of a mixed state; the first excited state denoted ^{27}Al, $p_{\frac{1}{2}}$, which was mainly *D* and partly *S* (*S*/*D* $\sim$ 10 per cent). A kind of anti-stripping, in which the bombarded nucleus 'seizes' a neutron, for example, ^{9}Be (*d*, *t*), and the capture and loss of neutrons as suggested by examination of magnesium-24, were discussed.

For (*d*, *n*) reactions, negative *Q* reactions are preferred rather than high positive *Q*, as for (*d*, *p*). Observations with nuclear emulsions show that in some cases neither theory fits. Finally, Prof. Skinner showed that the excited states of some mirror nuclei (carbon- and nitrogen-13, oxygen- and fluorine-17, nitrogen- and oxygen-15, and sulphur- and chlorine-33) are well known, and he suggested that correspondence between spins and parities is perhaps more significant than that for energies.

Dr. C. A. Ramm spoke of his work at Birmingham, in collaboration with E. R. Collins and C. B. Mackenzie, in which precision measurements of the energy of particles produced with a Cockcroft-type magnet have yielded accurate *Q* values for reactions. He discussed the sources of error in such experiments, particularly for the reaction ^{6}Li (*p*, α) ^{3}He. Study of target deterioration has shown that some novel problems arise.

Prof. L. Rosenfeld (Manchester) brought the session to a close with an account of the theory of nuclear models and excited states. He began by stressing that, in attempting to explain the properties of nuclear states, we are still very far from the ideal set by the theory of atoms. In this the predominant influence of the Coulomb field introduces an element of simplicity entirely lacking in the nuclear case. Moreover, our knowledge of the interactions between nucleons lacks the definiteness of the law of electric interaction. We cannot hope to deduce the properties of nuclei from the mere knowledge of the number of constituent nucleons, and we must take over from

experiment as basic assumptions the existence of closed shells as indicated by the magic numbers. This is the clue leading to the Jensen–Mayer shell model in which the additional assumption is made of a strong spin–orbit coupling with a sign such as to give rise to inverted doublets for the individual nucleon states. One may expect that some at least of the states of low excitation will correspond to the excitation of a single nucleon in an incomplete shell. The properties of such excited states are immediately predicted by the model. In experiments involving resonances, this type of excited state can be recognized by its having a larger width than those due to more complex modes of excitation.

Prof. Rosenfeld pointed out that direct experimental evidence supporting the assumption of large spin–orbit coupling is obtained in the scattering of nucleons by helium. Here the spin–orbit separation observed is ~ 5 MeV.

To improve the shell model it is necessary to investigate the result of the interactions of nucleons which are neglected in the first approximation. This problem has recently made great progress in two directions: the discussion of the mutual interactions in incomplete shells; and the interactions of these nucleons with the core formed by the closed shells. The first problem has been treated on the assumption of mainly central interaction between any two nucleons. The stationary states have been classified by methods of group theory, perfected by Racah, both for Russell–Saunders coupling (Jahn *et al.*) and for *jj*-coupling (Flowers, Flowers and Edmonds). Generally, the conclusions are found to be very sensitive to the assumptions made concerning the shape of the nuclear potential. The results of calculations by Talmi using a meson potential are completely different, as regards the order of succession of the excited states, from those obtained using a Gaussian potential.

The problem of interaction between the incomplete shells and the nuclear core has been most fruitfully attacked by Aage Bohr and Mottelson. The idea is that the interaction deforms the nucleus and excites oscillations on its surface. There appears to be a strong coupling between the angular momentum of the incomplete shell and that of the deformed nucleus. The predictions regarding the resultant angular momenta are then obtained by methods comparable to those used in molecular spectroscopy. In both cases, comparison with experiment reveals some discrepancies and shows the need for the next step, which should be to determine the combined effect of the two types of interaction described above.

In the discussion following the first session, Prof. R. Peierls (Birmingham) made a number of important points, and he deprecated the tendency to divide sharply between theory and experiment. He thought that at present the most important step is to ask the right question.

The π^0-Meson

In opening the afternoon session on meson problems, Prof. J. C. Gunn (Glasgow) surveyed π-meson theory in relation to experiment, and described the general considerations from which the pseudoscalar character of the π-meson can be deduced. In particular, detailed balancing applied to the reactions $p + p \rightleftarrows \pi^+ + d$ shows that π-mesons have zero spin, while the observed process $\pi^- + d \rightarrow 2n$ shows that they have odd parity, provided, as is plausible, capture of the meson takes place from a K-orbit. More detailed methods of approach were then considered by Prof. Gunn for some basic meson problems. Combined phenomenological and weak-coupling calculations indicate that mesons should be produced isotropically in the reaction $p + p \rightarrow \pi^+ + d$ (corresponding to capture of S-wave mesons in deuterium). In fact, a $\cos^2\theta$ distribution is found. It is difficult to explain this disagreement except by the breakdown of the weak-coupling approximation. The reaction $n + p \rightarrow \pi^0 + d$ is to be noted as a powerful test of the 'charge independence' hypothesis for meson coupling.

The weak-coupling treatment of quantum production of mesons, and of meson nucleon scattering, again shows little agreement with experiment. It has indeed proved most profitable to apply the methods of partial wave analysis to data on meson–proton scattering. This confirms the idea that these particles interact so strongly that they can no longer be regarded as simple structures. The two theoretical approaches which are clear at the present time are the *ad hoc* assumption of isobaric states to fit the experimental evidence or the use of the intermediate-coupling method.

Dr. R. G. Moorhouse (Glasgow) described his investigations using the intermediate-coupling method. The nucleon is represented as a superposition of states containing the bare particle, together with arbitrary numbers of mesons and nucleon pairs in given configurations. The variables are the amplitudes with which these states occur. Two cases have been considered: when the surrounding cloud contains only mesons; and when it includes nuclear pairs and no mesons other than those introduced in the pair creation. The first case gives wrong magnetic moments for the neutron and proton; but the second is more promising as the magnetic moments differ in absolute magnitude by a nuclear magneton.

Describing recent experiments on the decay of π^0-mesons, B. M. Anand (Bristol) said that examination of a large number of jets has shown that the life-time T is less than 5×10^{-14} sec. King at Bristol has observed electron pairs arising apparently in the second of the two decay processes: (*a*) $\pi^0 \rightarrow \gamma + \gamma$, and (*b*) $\pi^0 \rightarrow \gamma + e^+ + e^-$. Process (*b*) seems to be the more promising, for the evaluation of T and a method of time dilation applied to the photo-plates have given $T \simeq 1 \times 10^{-14}$ sec. A study of some fifteen hundred stars of low energy gives the ratio 80 for the probabilities of (*a*) to (*b*). The energy distribution of direct to related pairs is $\overline{E}_a/\overline{E}_b = 0{\cdot}86 \pm 0{\cdot}26$, which apparently confirms the theoretical value 1·0, so that the energy is shared equally between the two electrons and the γ-ray. Finally, Mr. Anand spoke of single electrons appearing to come from stars and the origin of which in some cases seems to raise interesting queries.

Dr. R. H. Dalitz (Bristol) discussed his theory of decay of π^0-mesons. In addition to (*a*) and (*b*) above, he considered: (*c*) $\pi^0 \rightarrow e^+ + e^-$, and (*d*) $\pi^0 \rightarrow 3\gamma$, noting that (*d*) is forbidden by charge conjugation. His theory gives for the ratio of probabilities $(a)/(b) = 80$, confirmed by experiment. He stressed the connexion with internal pair conversion, which has a low probability ($\sim 10^{-4}$) at energies ~ 1 MeV., as against 1/80 at the energies here involved.

The meetings for the first day of the conference closed with a discussion of the possible advantages of holding more conferences on nuclear physics. There seemed to be general agreement on the

desirability of extra meetings, confined to specialized topics in the field.

Beta Radioactivity

Dr. S. C. Curran reviewed the theory of β-decay and passed to discussion of the results of the Glasgow group with proportional and scintillation spectrometers. He listed the possibilities of disagreement with straightforward theory, which might show in the low-energy region of β-spectra. Here the proportional tube containing gaseous sources, particularly when supported with the scintillation spectrometer, is nearly ideal. Among the possibilities is readjustment of the atom consequent on the change of atomic number in the emission process. Assuming the adjustment energy goes entirely to the electron, a displacement of the spectrum along the energy axis follows, giving a 'hole' at the low-energy end. Tritium shows such a 'hole', but it is too extensive to be explained as readjustment. Work on radium-*D*, mercury-203 and nickel-63 does not support the view that the electron receives the whole energy.

The central problem of determining the mode of interaction (or combination of modes) has been attacked by investigating highly forbidden transitions. Study of rubidium-87 (half-life, 6×10^{10} yr.) shows that both C_{3T} and C_{3V} correction factors give excellent straight lines. This work with the proportional tube has been confirmed closely by G. M. Lewis using crystals of rubidium iodide (thallium) as their own spectrometers. Recent results for rhenium-187 give the transition energy as about 400 keV. and suggest the transition is probably at least third forbidden. This implies that stable osmium-187 has a spin of 11/2 or 13/2, an unusually high value possible, however, on the shell model. Dr. Curran stressed the possible close association of this model with the natural radioactive sources. For potassium-40, rubidium-87, lanthanum-138, lutecium-176 and rhenium-187, or the daughter elements, there seems to be a connexion with the important shell numbers 20, 50, 80, 106 and 112 respectively.

The curved crystal spectrometer used recently to examine the γ-rays of radium-*D* was described by Dr. G. T. Ewan (Edinburgh). A very sharp line at 46·52 keV. was observed, corresponding to the known excited state of radium-*E*. No line corresponding to a state at about 43 keV. was observed. In view of the absence of other apparently established γ-transitions, upper estimates to their possible intensities were given. The new results show that the mode of decay in some 20 per cent of the disintegrations of radium-*D* is still uncertain.

Dr. D. L. Pursey (King's College, London) spoke on his recent work on the theory of β-decay. This is concerned with the experimental determination of interaction in the theory of decay. The spectrum shapes of allowed and first forbidden transitions and the *ft* values of super-allowed transitions lead to the conclusion that the interaction contains either both the scalar and tensor or both the polar and axial vector invariants, the two interaction constants being roughly equal.

The decay of $^{228}MsTh_2$ was reported by Dr. C. G. Campbell (Edinburgh). A double β-spectrometer was used and the partial spectra separated; six such have been found with end-points and intensities as follows:

Energy limit	2·18	1·85	1·72	1·15	0·66	0·46
Intensity (per cent)	10	9	7	53	8	13

Photodisintegration

J. R. Atkinson (Glasgow) reviewed the field of photodisintegration in stimulating fashion. He divided the reactions into three categories—(i) γ, p; γ, n; (ii) γ, p, n; γ, d; γ, α; (iii) γ, stars—and he discussed for each the excitation curve, angular distribution, experimental methods and theoretical treatment. For (i) and (ii) the curves are about 5 MeV. wide for a large range of values of atomic number, but for (iii) there is resonance at discrete γ-ray energies. There appear to be anomalies in the form of the excitation curve and the angular distribution for the processes (γ, pn) and (γ, d). The stars appeared to be anisotropic. The theoretical models (Levinger/Bethe, Weisskopf, Goldhaber-Teller) leave much to be desired. The discussion of the work of the Glasgow team (with expansion chambers) centred on helium as target, and the criterion of selection was the close agreement of the quantum energy E_γ of the incident radiation as determined by two methods. Current work with the smaller Glasgow synchrotron on the disintegration of nitrogen promises to be fruitful.

F. K. Goward described the very interesting work which he and J. J. Wilkins are prosecuting at the Atomic Energy Research Establishment, Harwell, in which the photo-emulsion technique has been exploited fully in the study of stars; more recently, the gridded ion chamber has helped to improve the energy resolution of levels. The technique was admirably illustrated with slides of a variety of star-processes. For the reactions:

$$^{12}C + \gamma \rightarrow 3\alpha - 7{\cdot}3 \text{ MeV}. \quad (1)$$

$$^{16}O + \gamma \rightarrow 4\alpha - 14{\cdot}4 \text{ MeV}. \quad (2)$$

about 2,000 and 600 stars, respectively, have been measured. The quantum energy was deduced by adding the binding energy to the measured total energy release. The cross-section curve for (1) shows a doubly peaked curve, suggesting competition with (γ, n) and (γ, p) reactions and implying the formation of a compound nucleus. A series of narrowly spaced resonances ($\sim$ 1 MeV. apart) is probably superposed on a continuum, giving levels of carbon-12. Likewise, it seems that the levels of oxygen-16 are excited, and levels of intermediate nuclei—for example, beryllium-8—could be observed.

A paper on photodisintegration, by Mr. J. M. Reid (Glasgow), dealing with the application of counting techniques, was given at a special sectional meeting in the afternoon.

The S-Matrix

J. Hamilton (Cambridge) discussed the work of C. A. Hurst on the convergence of the renormalized *S*-matrix perturbation theory expansion (after Dyson), regarded as a power series in the coupling constant. The theory treated was a scalar meson field coupled scalarly to itself—the so-called 'φ^3' theory.

Estimation of the number of irreducible graphs of order n contributing to a chosen physical process gives $(n/k)!$ for large n, where k is a small integer, probably 2. The sign and magnitude of the contributions from these graphs are not easy to find, and Hurst limited his discussion to processes which do not relate to real particles, thus avoiding difficulties possibly arising from the creation of new particles. It is thought that the restriction can be thrown off by analytical continuation in the energy plane. For a

particular process the series of contributions from the irreducible graphs diverges in an oscillatory manner with great rapidity. When the coupling constant is small, say 1/137, successive terms decrease rapidly at first, but ultimately the enormous number of graphs becomes the predominant factor. In pseudoscalar π-meson theory the coupling constant may be in the range 4–40, and at no stage does the series even appear to converge.

During the discussion, Prof. Peierls pointed out that a weakness of the work is the lack of any estimate of the finite contributions from the self-energy and vertex parts occurring in the graphs.

The work of B. F. X. Touschek and of Dr. W. K. Burton on field equations and commutation rules was then described by the latter. Dr. Burton referred to a recent paper by J. Schwinger[1] which gives an account of a comprehensive scheme for the quantum mechanics of localizable fields based on an operator Lagrangian. The theory makes no appeal to the correspondence principle or an underlying classical theory, and all the results are derived from a single fundamental principle analogous to Hamilton's principle in classical theory. This theory has been shown by Burton[2] to lead to a particularly simple derivation of the *S*-matrix series in terms of the interaction Lagrangian. Schwinger describes how the commutation relations are to be obtained from the fundamental postulate; and, by studying examples from particle mechanics, Burton and Touschek found that the Schwinger method gives a unique prescription for the determination of the commutation rules for systems free from anholonomic constraints. If such constraints are present, the method may—in special cases—no longer apply as it stands. Equations of the Dirac type belong to this category, since the number of degrees of freedom is just half the number of co-ordinates appearing in the Lagrangian.

The final lecture, by Dr. J. S. R. Chisholm (Glasgow), dealt with the calculation of higher order *S*-matrix elements. Dr. Chisholm demonstrated explicitly automatic procedures for carrying out the calculations according to a prearranged programme. Previous efforts in this field appear as special cases of the general method which he detailed. Dr. Chisholm brought out clearly the principles described at length in his published work[3]. S. C. CURRAN

[1] *Phys. Rev.*, **82**, 914 (1951).
[2] *Phys. Rev.*, **84**, 158 (1951).
[3] *Proc. Camb. Phil. Soc.*, **48**, 2, 300 (1951); and *Proc. Roy. Soc.* (in the press).

PROGRESS OF CANCER RESEARCH

THE reviewer of a production like the Annual Report of the British Empire Cancer Campaign*, which covers a wide field of research, will naturally tend to limit his choice of investigations for description to those with which he feels at home, or which seem to him to be especially interesting, original or promising. The subjective element in selection is unavoidable and, in fact, will become more pronounced as cancer research extends, since the range of studies as a whole is beyond the scope of any one reviewer.

Carr, in experiments on the virus of Rous sarcoma, has found that it is recoverable from the leg of a chick when the muscle is extracted a few hours after injection; after 6 hr. it can no longer be detected in any quantity, but at 66 hr. it can again be separated in amount greater than was injected. It is believed that the infective virus disintegrates into smaller components inside the cell, that these multiply and recombine to give the infective virus. "All these considerations lead to the suggestion that infective virus is present in the cell for only a very short proportion of the mitotic cycle. It therefore seems probable that the malignant condition is caused by some earlier stage of the virus multiplication cycle, and this leads to the possibility that a tumour may sometimes result from a non-infective virus."

Investigations at the Chester Beatty Institute on chromosome abnormalities induced in *Drosophila* by chemical mutagens (nitrogen mustards, diepoxides, ethyleneimines, dimesyloxyalkanes) have shown that these changes are observed as partial deficiencies. This fact has been used in support of a theory of malignancy, the outline of which can be sketched in as follows: (1) Many carcinogens are also potent inducers of mutations in *Drosophila*. (2) There must therefore be some fundamental relation between carcinogenesis and mutation (hence the somatic mutation theory of cancer). (3) Mutagens acting on *Drosophila* induce chromosomal abnormalities, namely, deficiencies and minute deletions. (4) It is possible, therefore, that cancerous transformation also is an expression of a chromosomal deficiency, that is, an interference with the reproduction of the gene pattern. (5) Hence the cancer cell is a normal cell which has irretrievably lost something—clearly it has lost its growth-controlling mechanism. (6) The specific hormones control the growth of their target organs and xanthopterin brings about renal hypertrophy; therefore an obvious aim of cancer research must be to find a chemical compound or an enzyme which can replace the lost growth-controlling material of the malignant cell.

There exist some different types of chromosomal aberrations which are not permanent features of tumour tissue. In an account of the work of Koller and associates, it is stated: "From continued study of cytological abnormalities frequently observed in the cells of tumours induced by the aromatic nitrogen mustards it is clear that these are of 2 classes, those which gradually disappear in the course of serial transplantation, and those which continue to be transmitted to the descendant transplant generations, apparently indefinitely. Even these permanent abnormalities are, however, still regarded only as associated changes, and not in themselves the cause of the malignant alteration, which can clearly occur in their absence. They are nevertheless of great interest as suggesting a likely site of action of these carcinogens, and it is probable that the malignant transformation itself involves a much less tangible or even 'invisible' effect on the chromosome or gene".

Ludford, who has been studying variations in size and structure of the malignant cells of transplantable tumours in inbred strains of mice, says: "On the basis of these observations it seems justifiable to conclude that cellular polymorphism correlated with variations in chromosome numbers and aberrations of the process of mitosis are not specific features of malignancy but occur, although to a lesser extent, in normal tissues. This suggests the probability that after cells have become differentiated the full chromosome complement is no longer essential for their continued life and functional activity".

* British Empire Cancer Campaign 29th Report (1951). Edited by Sir Heneage Ogilvie (11 Grosvenor Crescent, London, S.W.1).

Cancer of the bladder in dye and rubber workers, and skin cancer due to mineral oils in the engineering industry, have been the subject of investigation by Case and by Woodhouse and Hieger. Case, in a statistical examination of bladder cancer, finds that the great increase of this disease between 1901 and 1950 cannot be entirely attributed to an ageing population, nor to improvements in diagnostic method. The occupational study of the rubber industry shows that a hazard is located in the mixing, extruding and vulcanizing sections of the industry, and that the risk was introduced between 1915 and 1930. This date would be compatible with the time when carbon black, some organic accelerators and anti-oxidants first began to be used on a large scale.

The biological testing of fractions of petroleum oils from different sources has as its objects the identification of the active agent in the oils and the development of a technique for assessing the industrial risk attached to the use of any one particular oil. Fractions of petroleum from oil-fields in the Middle East, Venezuela and the United States were prepared by distillation under conditions in which cracking was avoided in order to preserve the composition of the oil as nearly as possible in its original state. These fractions when tested by an elaborately designed series of experiments on mouse and rabbit skin showed pronounced differences of activity; they were much more carcinogenic for rabbit skin than for mouse skin—a further example of the unpredictable differences of susceptibility of different tissues and species to carcinogens.

Doll has conducted an inquiry into factors which may affect liability to cancer of the cervix uteri. It has been shown by a large volume of data that Jewish women have a lower incidence than Gentile women and that child-bearing is conducive to this form of cancer. Gagnon has now produced some unique evidence on this question. In the medical records of a population of nuns (annual average 3,280) in Quebec for the past twenty years, no case of cancer of the cervix was found. Inquiry is being made as to whether a similar investigation could be made in any other country (for example, Bavaria).

Sir Ernest Kennaway and collaborators have carried out an intensive examination of lung cancer, particularly from statistical material and by a study of carcinogens in the atmosphere and in tobacco smoke. Although it is now highly probable that cigarette smoking is an important factor in the very rapid increase in lung cancer in the past few decades, many other problems of lung cancer remain at present unexplained. For example, cancer of the larynx has shown no equivalent increase during this time. In Norway and in Mexico, cancer of the lung is about as frequent in men as in women; in England it is much more common in men; deaths attributed to cancer of the lung in both sexes and to cancer of the larynx in males are higher in the more urban districts, while in women the relation is reversed. The role of the geographical factor in differences of incidence of cancer presents some attractive problems. "The peculiar position of Wales in relation to cancer was first observed by Stocks (1930), who discovered the high incidence of cancer of the stomach in the north-western counties of Wales."

Gwyn and Salaman, in experiments on co-carcinogenesis, have found that if the skin of a mouse is given a single painting with 9 : 10-dimethyl-1 : 2-benzanthracene, followed after an interval of six weeks by treatment with co-carcinogen (croton oil in paraffin oil), the rate of appearance and yield of tumours suggests: (1) that there is a critical size for tumours produced by this method which is rather less than that of the smallest visible; tumours smaller than this do not continue to grow—in fact, regress—if co-carcinogenic treatment is stopped; (2) the change produced by croton oil in mouse skin previously painted with a carcinogen is a gradual one; it is reversible during the greater part of its course, but becomes irreversible and independently progressive not long before the appearance of a visible tumour.

At Leeds, Dmochowski and co-workers have continued their researches on the Bittner milk factor. Electron microscope photographs show that in human milk, and in extracts of human breast tumours, especially from pregnant women, there exist particles of a size approximately the same as the Bittner agent. The virus is not antigenic in mice, and the antibodies elicited in mice react with extracts of mouse tumours whether or not they contain the agent as well as with different normal mouse tissues. No evidence could be found of a common antigen in human and mouse tumour extracts. Electrophoretic estimations show that the infective dose of the milk agent is extraordinarily low, namely, 3×10^{-7} µgm. of nitrogen.

Dmochowski finds that after eighty-six successive transplantations of the mammary tumour, the milk factor can no longer be detected, although there is no histological difference between the tumour at its eighty-sixth and forty-second passage. Apparently the presence of the milk factor is not a permanent feature of this transplantable tumour, and the cells can continue to multiply even when the agent cannot be detected by the technique employed. A similar disappearance of the virus from the transplantable Shope rabbit carcinoma has been described by workers in the United States. Dmochowski refers also to experiments demonstrating the appearance of the milk factor *de novo*, as reported in studies by Bittner.

Bonser and Jull have used a new method of testing carcinogens on the bladder by introducing the compound as a suspension in a paraffin wax pellet directly into the dome of the bladder of the mouse. Epithelial changes starting with hyperplasia and squamous metaplasia, and going on to benign and malignant hyperplasia, resulted from the introduction into the bladder of 20-methylcholanthrene, 2-amino-naphthol, and 3 : 4 : 5 : 6-dibenzcarbazole. Claysen reports that a relationship exists between species susceptibility to the carcinogenic action of 2-naphthylamine and the proportion of this compound which is excreted as 2-aminol-1 naphthol conjugates. Moreover, since 2-amino-1-naphthol is also carcinogenic when injected subcutaneously, the suggestion is put forward that in carcinogenesis by 2-naphthylamine the amine has first to be converted to the naphthol.

At the Sheffield centre, strenuous efforts have been made to induce stomach cancer in rabbits, rats and mice by injecting rapidly-acting carcinogens into stomach fistulæ, by feeding hot food at 55° C., by administration of 2-acetyl-aminofluorene or methylcholanthrene with croton oil by mouth, by exhaustion of the mucosal secretion with dodecyl sulphate or with 50 per cent ethanol followed by 9 : 10-dimethyl-1 : 2-benzanthracene in the drinking water. The results were negative. "All the available evidence still suggests that the stomach is refractory to chemical carcinogenesis because of its powerful mucous

barrier. Perhaps the main value of all this work is that it suggests that the inducing agent in stomach cancer is not an extrinsic chemical carcinogen."

Pybus and Miller, at Newcastle, have carried out experiments somewhat on the lines of Strong's method, namely, the injection of mice with methylcholanthrene for a number of generations to see if subsequent generations will contain mutations observed as spontaneous neoplasms without the necessity of applying carcinogens.

Lasnitzki at Cambridge has confirmed Craigie's report that mouse sarcoma 37 consists of at least two types of cells, the more active variety (round cells refractile in phase contrast) being convertible *in vivo* and *in vitro* into the more differentiated spindle cells.

Peacock has reported that hybrid mice from *CBA* strain (virus-free) mothers and C_3H (virus-bearing) fathers can acquire the virus if the father remains in the breeding box during pregnancy and the puerperium. If the *CBA* mother is transferred to a sterile breeding box early in pregnancy and remains segregated until the litter is weaned, the female hybrids show no greater incidence of mammary cancer than pure line *CBA* females.

Peacock has been more successful than the Sheffield workers in inducing stomach tumours in mice; he used feeding with carcinogens and with cottonseed oil heated to 350° for some hours. In an experiment in which the oil was fed for 300 days in a series of mice of which 230 lived more than 400 days, fifteen cases of papilloma and six of squamous carcinoma or adenocanthoma of the forestomach and adjacent glandular stomach and three cases of adenosis of the pylorus were found. "Thus it seems probable that the 21 cases of tumour of the forestomach among 230 mice fed with heated cottonseed oil were directly related to this treatment. Though a 10 per cent yield is small compared with many experimental results, it is at least as high as the incidence of cancer of the stomach in the human subject." However, the stomach tumours evoked in the mouse are rather different from human gastric cancer, and Peacock suggests that this difference is due to the occurrence of gastritis, pernicious anæmia and achlorhydria, which is common in man but rare in animals.

The fundamental problems of dosimetry are still receiving a large amount of attention in practically every centre concerned with treatment by any form of radiation. Methods of measurement vary from the proportion of survivals of the broad bean root to the reduction of ceric sulphate. The use of photographic nuclear research emulsion for fast-neutron dosimetry is also being compared with the more usual method of using an ionization chamber with walls of a gelatin mixture. Depth-dose measurements vary from those made on a 30-MeV. beam in a water phantom, to beta-rays using a stack of films as phantom. The protection of workers in these fields is also being continually studied. In a number of departments a film badge service is provided, and one report discusses the method of determining the energy of scattered rays by means of secondary electronic emission from metal foils. Reports from two centres using a 30-MeV. synchrotron indicate that while treatment is tedious owing to the low output of 9–10 r./min. at 1 metre, yet useful information is being gleaned about the distribution of the dose in tissue. The few patients who have been treated have shown encouraging results.

Numerous reports indicate the ever-increasing use of radioactive isotopes as a tool for research as well as for diagnosis and therapy. Considerable strides have been made in the design and operation of scintillation counters, and reports from a number of centres indicate that the increased sensitivity of this means of detecting radiation should lend itself to a much more efficient study of radioactive material in the body. A 4π scintillation counter for the absolute standardization of radioactive isotopes is also reported. The importance of absolute standardization, particularly of radioactive isotopes in frequent use, has been realized, and work is going on in several centres to attempt to reach agreement on this point. There is an increasing demand for discrete sources of radiations, and work is reported on surface applicators, using the gamma radiations from gold-198, which is spread over a 'Perspex' or polythene mould in the form of gold foil of varying thickness, and the entire unit then irradiated at the Atomic Energy Research Establishment. Cobalt-60 is now used as a central source in the intracavitary treatment of carcinoma of the bladder and also in the treatment of carcinoma of the cervix. Superficial beta-ray applicators using phosphorus-32 (as red phosphorus) incorporated into plastics are also giving encouraging early results. The installation of two cobalt-60 beam-therapy units using up to 1,400 Curies of cobalt-60 is reported from Canada (see also *Nature*, **168**, 1035; 1951).

The clinical and pathological reports consist chiefly of the continuation of orthodox analyses of malignancy at various sites with correlations including stage, histology and response to treatment. The findings confirm the value of histological grading in assessing prognosis. Similar investigations are being carried out independently at a number of centres in Great Britain, but there is little evidence of any co-operative planning. The most detailed survey reported is on seventy-four cases of nephroblastoma from the Hospital for Sick Children.

At the Chester Beatty Institute it is found that 1 : 4-dimethanesulphonoxybutane given in long courses of small doses has proved capable of producing remissions of therapeutic value in myeloid leukæmia. At both the Westminster and the Christie Hospitals it has been found that the nitrogen mustards are useful in the treatment of advanced Hodgkin's disease.

Glücksmann and his colleagues are studying the mechanism of lymph-node involvement and the reaction of the node to the presence of tumour in cancer of the cervix. They have also accumulated impressive results on the value of the cytological analysis of serial biopsies in the assessment of the radiocurability of cancer.

Cuthbert Dukes has confirmed the frequent development of cancer of the large bowel in long-standing cases of ulcerative colitis. He and his colleagues have found that precautions recently adopted to prevent implantation of cancer cells during the operation of restorative resection for cancer of the rectosigmoid have indeed prevented the recurrences at the suture line which were met with formerly.

Price, at Bristol, in an analysis of thirty-six cases of osteogenic sarcoma, found the mitotic ratio (the number of resulting nuclei to one in mitosis) to be the most reliable index of malignancy. A mean mitotic ratio of 238 to 1 was obtained for the whole series, based upon an examination of at least 2,500 nuclei for each count. The tumours were divided into three grades of malignancy on the basis of the

mitotic ratio. These showed good correlation with the time of survival of the patients in months from the date of the presenting symptom. The conclusions are most promising, but it would appear that the number of mitotic cells counted, especially in the 'low-grade' malignancies, must have been extremely small. His published article on this work does not give the actual number of mitotic cells counted and therefore does not dispel statistical doubts about the method as it stands.

PHYSICAL CHEMISTRY OF PROTEINS

A GENERAL discussion on "The Physical Chemistry of Proteins" was held by the Faraday Society in the Department of Zoology, University of Cambridge, during August 6–8. During the meeting, introduced by Dr. J. T. Edsall of Harvard University delivering the sixth Spiers Memorial Lecture, some twenty-five papers, a large proportion by foreign authors, were presented.

The programme was divided into five sections arranged in order of increasing complexity: (1) experimental techniques, (2) low molecular weight proteins, (3) high molecular weight systems, (4) protein interactions, (5) conjugated proteins. An audience of 350–400, containing many guests from abroad, attended.

Dr. Edsall, a Fulbright Fellow of the University of Cambridge, began by reviewing the fundamental changes in our ideas on proteins since the middle twenties, when little quantitative information was available. Subsequent years saw the development of the ultracentrifuge and other physical methods by which information on the size and shape of many proteins has been obtained. Among recent developments, Dr. Edsall mentioned particularly the work of Sanger and co-workers, which has provided very complete information on the sequence of amino-acids in insulin, and the structural suggestions of Pauling, Corey and co-workers. Illustrating the state of our knowledge of the physical chemistry of proteins, Dr. Edsall dealt in detail with two important proteins —fibrinogen and serum albumin. There was general agreement that fibrinogen is an asymmetric molecule of molecular weight *c.* 400,000, but many more detailed questions and the mechanism of blood clotting require further study.

Serum albumin is one of the most-studied proteins. The molecular weight was thought to be *c.* 69,000 until very recently, when new experimental work has indicated that a somewhat lower value may be correct. As to the shape of the molecule, the greater part of the data is in accord with an ellipsoid of rotation of low axial ratio; details remain to be settled. While the molecule is supposed to be relatively rigid in solution, it is possible that some flexibility of the surface exists; such a property would go far towards explaining the ability of the molecule to combine with a large variety of organic and inorganic materials. Dr. Edsall considered in detail the binding of zinc and mercury atoms.

In section 1, only the more recent advances in experimental techniques were considered. In a paper by A. Tiselius, zone electrophoresis in filter paper and other media was reviewed. Since separate bands are thus produced, the method has distinct advantages over boundary electrophoresis as a preparative tool. It can readily be operated on a micro scale, at low concentrations and for a variety of materials of low molecular weight as well as macromolecules. On the other hand, electro-osmosis and adsorption may hamper quantitative work, and special measures are necessary if such effects are to be avoided. G. Weber presented a paper on the use of measurements of the polarization of fluorescence in investigating proteins in solution. Results on several protein preparations were quoted, among which those on bovine serum albumin, indicating reversible dissociation at low salt concentration and acid *p*H's, were of especial interest. Variation of the protein concentration causes no apparent effect on the dissociation. Confirmation of these results was reported from osmotic pressure and sedimentation-diffusion studies. Several workers, however, were doubtful about this interpretation, attributing the apparent dissociation to effects of the high positive charge of the molecule under the conditions of the experiments. A final paper in this section, by J. S. Falconer, D. J. Jenden and D. B. Taylor, dealt with the application of solubility measurements to the study of complex protein solutions and to the isolation of individual proteins. In illustration, the fractionation of rat liver was considered.

The section on low molecular weight proteins began with a paper by P. Doty and G. E. Myers dealing with the thermodynamics of the association of insulin. Light-scattering measurements at acid *p*H's and varying salt concentration were used to evaluate the constants governing the equilibria between monomer, dimer and trimer over the range 20°–40° C. From discussion of the molecular weight of the insulin monomer, it would appear that the bulk of the kinetic data now supports the value 12,000. In a paper by H. Neurath and co-workers, the kinetic behaviour of trypsin and related molecules was considered. When trypsin is examined under conditions favourable to enzymatic activity, the sedimentation constant, varying with the age and *p*H of the protein solution, corresponds with autolysis of the protein. On the other hand, when the enzyme is stable and inactive, no such anomalies are observed. Trypsinogen and the diisopropylfluorophosphate derivative similarly show normal behaviour. A molecular weight of 24,000 was reported for the inactive proteins. G. E. Perlmann presented an electrophoretic study of enzymatically modified ovalbumin and casein. The reactions considered were: (1) the ovalbumin—plakalbumin transformation in which carboxyl groups are liberated, and (2) the dephosphorylation of ovalbumin, plakalbumin and casein. In each case, characteristic changes in electrophoretic mobilities and patterns were produced; electrophoresis is thus a useful tool in following enzyme changes involving charged groups. E. Barbu and M. Joly dealt with the transformation of certain globular into fibrous proteins by moderate heating, salt effect, or high pressure. Several physical methods were utilized, and the authors suggested that end-to-end aggregation rather than unfolding of the molecules is responsible for the fibrous products obtained. Denaturation was treated in the light of the results obtained. In the following discussion, several workers directed attention to denaturation reactions which would be difficult to explain by end-to-end aggregation and for which chain unfolding is the more likely explanation.

In section 3, the first paper, by P. Johnson and W. E. F. Naismith, reported experimental results

on reversible association–dissociation reactions occurring in the conarachin fraction of the groundnut globulins. Higher ionic strengths and *p*H favour the dissociated form, whereas low ionic strength and *p*H's near the isoelectric point give large proportions of association products. Light scattering, which shows the rapid establishment of equilibrium, confirms sedimentation results; but electrophoresis gives no indication of the reactions occurring. In the discussion, attention was directed to the possible effects of rapid equilibria on the behaviour of moving boundaries. In a paper by S. Shulman, the effects of certain ions and neutral molecules on the conversion of fibrinogen to fibrin were considered. Many compounds, under similar conditions, are found to delay clotting by at least twenty-four hours (inhibition), though this action is reversible. Others cause much less delay in clotting (retardation). Correlation between the structures of the different compounds and their inhibitory action was attempted. Miss E. M. Petri and A. J. Staverman dealt with the electrochemical properties of lupin seed protein. The isolation and chemical analysis of the protein were described; membranes prepared from it were investigated with respect to their electrochemical behaviour. The effect of various chemical modifications has similarly been studied. Considerable discussion of the nature of the reactions involved followed.

The remaining papers in section 3 discussed muscle and its proteins. G. Hamoir described an electrophoretic study of the muscle structural proteins —myosin, actin, actomyosin and tropomyosin— rabbit and carp muscles mainly being used. Dr. Hamoir considers that his results demonstrate the infrequent occurrence of interaction between the different components; but in the discussion following, it appeared that other workers do not agree that electrophoretic diagrams exclude such effects. In part 1 of a paper on energetics and molecular mechanisms in muscle action, M. Morales and J. Botts summarized experimental data on thermoelastic properties of myosin threads, and on light scattering and kinetic measurements on actomyosin – adenosine triphosphate systems. This was interpreted in terms of a theory which assumes that the elastic particles contract by virtue of the increased entropy resulting but extend by reason of electrostatic forces. In part 2, by T. L. Hill, several simplified though possible models of the basic elastic element were considered, and the detailed properties were calculated by statistical thermodynamical treatments. T.-C. Tsao and K. Bailey presented a paper on aspects of polymerization of proteins of the muscle fibril— tropomyosin, myosin and actin. Tropomyosin and actin react very differently to the addition of electrolyte. Myosin, of greater constancy in its molecular weight, is thought by them to contain two types of sub-unit, a cyclic and an open-chain unit, each requiring special conditions for isolation. A detailed discussion of these papers followed.

Prof. L. Pauling introduced the proceedings of section 4 with a speculative discourse on the different types of association phenomena which are likely to follow mild modification of a protein system. For extensive association to occur, a single molecule must be provided with at least two active points on its surface; head to tail aggregation would then produce a helix the character of which would be determined by the relative positions of the reactive points on the protein surface. Different types of packing of such helices, stabilized by appropriate forces, as well as their interpenetration in various ways, were further possibilities. This approach, though speculative (and termed 'snip and fiddle' by one speaker) may well be basic to many aggregation phenomena involving proteins. A paper by E. J. Cohn and co-workers dealt with the interaction of plasma proteins at physiological *p*H with metals, alkaline earths, carbohydrates, and formed elements of the blood. Much of the information presented is now being utilized in the Harvard laboratory in new fractionation procedures for the plasma proteins. I. M. Klotz and J. Ayers reviewed earlier work on the binding by serum albumin of organic anions and cations and described new work with related neutral molecules. The results indicate that the protein undergoes configurational changes with change of *p*H or electrical charge. Low hydroxy-amino-acid content was discussed as a cause of the binding ability of serum albumin, and, in confirmation, the binding of α- and β-casein is found to be appreciable though lower than that of serum albumin. B. S. Harrap and J. H. Schulman presented work on the influence of salt on the size and shape of a complex between sodium dodecyl sulphate and bovine serum albumin. Using viscosity and light-scattering measurements in salt solution, definite complexes of low asymmetry were indicated; in absence of salt no definite complexes occurred, though uncoiling of the molecules was indicated. E. Gorter and L. Nanninga reported a detailed study by physical and other methods of the interaction of several proteins with heparin, suramin and chondroitin sulphuric acid. The interaction occurs between the SO_3^- groups of the latter compounds with positive groups on the protein, and is therefore very dependent on *p*H. The action of heparin as an anticoagulant was discussed in the light of these results. M. Fleming and D. O. Jordan presented results of an electrophoretic study of calf thymus deoxypentose nucleoprotein and of tobacco mosaic virus. Under certain conditions, the nucleoprotein dissociates into two fractions, and it is postulated that one fraction is protein, leaving a conjugate richer in nucleic acid. The final paper in this section, by R. J. Goldberg and J. W. Williams, was concerned with the antigen–antibody reaction. Adapting the statistical mechanical treatment of three-dimensional polymer condensation to the combination between antigen and antibody, predictions of the position of inhibition zones and antibody–antigen ratios in precipitates have been compared with experiment.

Section 5 began with a review of conjugated proteins by Prof. M. Stacey. Concentrating on complexes of proteins with nucleic acid and carbohydrates, Prof. Stacey mentioned particularly virus and bacterial nucleoproteins, the transforming principle of pneumococcus, mucopolysaccharide blood-group factors and certain recently studied mucoproteins. F. B. Seibert dealt particularly with tuberculin proteins, prepared from unheated tuberculin filtrates as well as live bacillary bodies. A study of their amino-acid content, electrophoretic mobilities, ultraviolet absorption, nucleic acid and carbohydrate content was considered in relation to their biological potencies. E. J. Ambrose and J. A. V. Butler presented data on the swelling of nucleoprotein films in the presence of various salts. The concentration of salts required to prevent swelling is of the same order as that required to precipitate the nucleoprotein from solution. Infra-red absorption and double

refraction of partially orientated films is compatible with parallel arrangement of β-polypeptide chains in the direction of stretching, the planes of the purine and pyrimidine rings lying perpendicular to this direction. Other structures are, however, possible. K. Meyer presented evidence for the existence of protein complexes of hyaluronic acid and chondroitin sulphates from hyaline cartilage and connective tissue. Reversibly formed polar complexes with the protein are suggested except in the case of chondroitin sulphate from connective tissue, which is stably linked to protein. A. G. Ogston and J. E. Stanier have isolated the hyaluronic acid complex from synovial fluid by ultrafiltration, since they believe that precipitation affects the physical properties. Such preparations contain 27 per cent protein, the removal of which caused a change in properties. Physical methods have indicated that the complex exists as a random coil of nearly spherical shape and large hydration. Its biological function was discussed.

OBITUARY

Sir Richard Gregory, Bart., F.R.S.

"My particular mission has been to make men of science conscious of their power and influence in shaping civilized life." So wrote Sir Richard Gregory in his message of farewell published in *Nature* of January 7, 1939, when he resigned from the editorial chair which he had occupied with such distinction for so many years. Throughout his long life, which came to a close on September 15, his interest in science for its own sake, and equally for the appreciation by others of its value and significance for humanity, was a driving force which brooked no obstacle, and happily that interest was sustained to the end.

Richard Arman Gregory was born in Bristol on January 29, 1864. His first post was as laboratory assistant at Clifton College. From there he passed on to the Royal College of Science, London, where he met several of the men who were to exert such an influence on him, as he on them, in later years—H. G. Wells, T. H. (later Sir Thomas) Holland, and especially Sir Norman Lockyer. He became research assistant to Sir Norman, and from that period arose a lasting love for astronomy and astrophysics. At this time he began to contribute occasional notes to *Nature*, of which Sir Norman had been editor since its foundation in 1869, and in 1893 he was appointed sub-editor of the journal. This marked a turning point in his career. Until then, his first interest had been astronomy, with the general feeling for science as a whole and its applications to human welfare. From then on, this second interest grew in intensity, and as the years went by and Lockyer left *Nature* more in the hands of his young colleague, it became his guiding influence. In articles, in lectures and addresses, he was never tired of developing and enlarging this theme.

While Lockyer had established the general lines on which *Nature* was conducted, and built up its reputation, Gregory did not hesitate to introduce innovations. Thus to make the journal a living force in the nation and the whole world of science, he felt it was necessary to publish more than occasional leading articles; and in due course—but not without a certain amount of opposition—he got his way, and the leading article expressing a point of view on matters scientific or their significance became a regular feature of the journal. For some fifteen or sixteen years of this period, he virtually conducted the journal himself, carrying out administrative duties as well as the normal tasks of sub-editor. During his annual holidays, he remained in touch by post. In 1919, Lockyer retired, and Gregory took over the full responsibility which he had already been exercising for some years. His work continued, for he was a true working editor, marking manuscripts for the printer and seeing the journal through the press week by week with all the attention to detail such work demands.

There was never an editorial committee; neither was there even a special panel of reviewers. The entire scientific world, both at home and abroad, has always been *Nature's* willing advisers and critics. Thus, through this valuable freedom from committee control and especially through the integrity and fearlessness of its editor, was Sir Richard able to contribute very largely towards making the journal what it is—a journal of science, published for men of science, written by men of science. He accepted the saying that 'a good editor wears out the soles of his shoes before the seat of his pants'; and was always ready to consider fresh views even if they conflicted with those accepted.

In spite of the heavy load of work which he assumed in this way, this did not by any means exhaust Gregory's seemingly unlimited store of energy. A short period of teaching in the Dockyard School at Portsmouth earlier on, coupled with his own personal experiences, persuaded him that there was a dearth of good school science text-books. Starting with astronomy and what used to be termed 'physiography', he began writing text-books which quickly made their mark for their accuracy and practical approach, and their appreciation of students' difficulties. Alone and in association with others, notably the late H. E. Hadley and A. T. Simmons, he wrote and edited a number of such books, many of which are still in use both in Great Britain and overseas after passing through several editions. By his sustained interest in scientific developments he was able to keep these books in line with scientific progress, even within the past two years.

This interest in education also showed itself in his activities in the British Association. He was one of the leaders in the formation of Section L (Education) of the Association, and for its first ten years served as one of its secretaries or its recorder. In 1922 he was president of the Section. In 1899 he helped to found the *School World*, which was later incorporated in the *Journal of Education*, and he was joint editor until 1938.

Almost as a by-product of his work for *Nature* was his book "Discovery: or the Spirit and Service of Science" published in 1916, in which he outlined in his characteristically clear and simple style some leading scientific discoveries, using them to illuminate his perennial theme, the worth of science.

From an early date, Gregory had been in considerable demand as a lecturer. On the platform he divided his attention between astronomy and the social implications of science; and as the years went by he identified himself more and more with the latter topic. Here may be mentioned his work for the British Science Guild. This body, formed to promote the appreciation and application of scientific

methods in public affairs (and incorporated in 1936 into the British Association), owed much to his untiring activities. At the close of the First World War, the Guild promoted a very successful British Scientific Products Exhibition, as a result of which Gregory was awarded the honour of knighthood.

A list of scientific societies which honoured him by electing him president ranges from the Science Masters' Association (1927), through the Royal Meteorological Society (1928 and 1929), to the Conference of Educational Associations (1931). Finally, just before the ill-fated Dundee meeting of the British Association was abandoned in 1939, he was elected president for the ensuing year and held office throughout the Second World War. During this difficult period he was ever mindful of the Association's affairs and even succeeded in organizing limited meetings at Reading, Manchester and London. Each body with which he became associated from time to time had his enthusiastic attention and support, and profited from his wide knowledge of men and affairs.

In 1931 he was created a baronet. Honorary degrees were conferred on him by the Universities of Leeds, Bristol and St. Andrews; but the scientific honour which he probably prized most was his election as a Fellow of the Royal Society under the rule which empowers the Council to recommend election "for conspicuous service to the cause of science". This was in 1933, when he was recovering from a long illness which had kept him—albeit very unwillingly—from the editorial chair for two to three months. This indeed was the first time since his appointment to *Nature* that he had been compelled to lay aside his duties and self-imposed tasks for so long a period. Yet even during that time he arranged to see one or the other of his assistant editors to discuss the journal.

It is probably no exaggeration to say that, by correspondence and personal contact, Sir Richard had a wider acquaintance with scientific men throughout the world than any other individual during the first two or three decades of this century. These friendships, many of which were warmly confirmed when visitors from overseas came to Great Britain, were strengthened and extended by three visits, to South Africa (with the British Association), to India and to the United States, where he delivered the Elihu Root Lecture in the Carnegie Institution of Washington in 1938.

Since Sir Richard was within two or three weeks of his seventy-fifth birthday when he retired from the editorship of *Nature* and took up permanent residence in the charming old Manor House at Middleton-on-Sea, it might have been thought that he would be content to rest from his labours. But as has been said, he sealed his long connexion with the British Association—he had attended practically every meeting for more than fifty years—by accepting the presidency and, as it transpired that this was for a long period (1940–46), he still worked for it while he was supposed to be living in retirement. This was not his only activity. He maintained correspondence with his many friends, and any appeal which seemed to offer a chance of promoting the cause of science or its appreciation was sure of his sympathy and advice. For example, during this period he was largely instrumental in securing the transfer of the Norman Lockyer Observatory at Sidmouth, of which he had been chairman of the governing body for many years, to the University College of the South-West, Exeter, thus ensuring its future.

One concluding word: we have tried to give an impression of the intense activity which filled Sir Richard Gregory's life. But he was no mere automaton, for he showed a very human enjoyment of his manifold interests, and we who worked with him always found him a very sympathetic, understanding and kindly man.

Sir Richard was twice married. In 1888 he married Kate Florence Dugan (*née* Pearn), who died in 1926 after a long and distressing illness; his son and daughter by this marriage both predeceased him. Secondly, in 1931, he married Dorothy Mary, daughter of the late Dr. William Page, general editor of the "Victoria County History", who survives him. Lady Gregory was his constant companion and helper throughout their married life, and her care and attention were a source of much happiness during his declining years.

THERE are very many of us who held Richard Gregory in close affection—scientists most of us, of all ages, but many with other activities and interests; and we are all feeling very deeply the gap which his going has left in our circle. We could not wish him to linger in his final illness; but, as members of an even much wider community of all who work in science, or are concerned in any way to promote the recognition of its present and future importance in the world, we are feeling sadly bereft of his genial presence, his tireless enthusiasm and his doughty championship. We seem to be looking at the end of a great chapter, with the closing of a long life so completely devoted to science and to all who serve it, during the period in which he watched its amazing development. When we heard his telegram of apology read at Belfast, it was heartening to feel that our gallant old friend still kept so much of his buoyant humour and that the flag of his courage was still flying, in face of the end which he must have known to be near.

A full tribute is being paid elsewhere to his central and most direct service to the progress of science, as the Editor of *Nature*, and to his other work for scientific education at all levels. We who knew him, however, in the intimacy of friendship, are thinking most now of his cheerful, generous, lovable personality, of his memory filled to overflowing with so rich a variety of knowledge and anecdote, of the racy, inconsequent, garrulous flow of his reminiscences. What a life-story he could have written!—from the days of his early, heroic climbing of the educational ladder—there were no escalators then—until, for well over half a century, he made friendly contacts with Britain's scientists, from the greatest to the least, and with many from other countries. Few, indeed, have been so widely known and trusted. Our deepest sympathy, in her bereavement, is with the brave and gentle comrade who brought him such happiness, and cared for him with such loving devotion in his later years.

H. H. DALE

MAY I be allowed among many others to pay my tribute to the work of Sir Richard Gregory in raising science to its present position in our national life, and particularly in insisting on the need for giving it a higher place in our educational system than it had had before. He early recognized the importance of developing agricultural science in Great Britain, even in the days before it was accepted at the universities as suitable for inclusion in their syllabuses, and he

always insisted that agricultural education, widely admitted as necessary at least for countrymen, must be based on sound scientific research.

It will not easily be forgotten at Rothamsted how he helped the appeal for funds that had to be made in 1934 when the Lawes family, owners of the estate which included the experimental fields and the laboratories, found they could retain it no longer but must part with it. The fields were then, in the language of the time, 'ripe for development', and builders were already assessing the possibilities for villa residences; no Treasury grants were available for the purchase; the money had all to be raised privately and quickly, and times were hard. Sir Richard gave the appeal whole-hearted support: he and H. G. Wells jointly wrote a letter to *The Times* in which with his accustomed lucidity he expressed his views on agricultural science: "whatever may be said of other branches of science", he wrote, "the results of research in agriculture cannot be used for purposes of destruction but only to give mankind knowledge by which the factors that determine the production of food may be effectively guided and controlled for the comfort of all. No higher motive of research than this can be conceived".

This was no mere passing expression of opinion: it was his consistent attitude to the subject and it inspired his friendly attitude to the workers. Critics had sometimes asserted that they should devote themselves mainly to the solution of specific farm problems; he always supported the Rothamsted view that their proper function was to build up a systematic science which should relate the facts and seek the underlying causes; it would then be possible to make better use of the facts than when they were only imperfectly known and understood. He had the personal link with Rothamsted that his only son Edgar, after retiring early from the Indian Army, joined the staff as guide demonstrator and thus became one of the pioneers in the art of presenting agricultural science to two completely different audiences: the countryman who already knows many of the facts, and the townsman who is often completely ignorant of them but who depends for his daily bread on their proper understanding by the right people. I always hoped that father and son might collaborate in producing a simple book setting forth the material in easily understandable language, but Edgar's untimely death and Sir Richard's many other activities prevented this. But his services to agricultural science, though quiet and unobtrusive, remain in the memories of those who knew him. E. John Russell

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Sir Richard Gregory was president or chairman of many societies and congresses, including the Royal Meteorological Society, the Geographical Association, and also the British Science Guild until that was merged, at his instance, with the British Association in 1936. His kindly spirit set store by the social contacts of conferences only less strongly than did his eagerness to further the progress of science. It is therefore probably true to say that his first and last love among the societies to which he belonged was for the British Association. Of this he became an annual member in 1896 and a life member in 1901. There was no more regular attendant at its annual meetings than he, and the last of these at which he was seen was that at Edinburgh in 1951. This his poor health compelled him to leave before its finish, and at the recent meeting in Belfast his telegram of greeting to the Council was welcomed with inevitable regret.

Gregory's early activities in the Association were concerned with the establishment of the Section of Educational Science in 1901, and with work on various committees appointed at the instigation of that Section. He acted in due course as a secretary and as recorder of the Section. But his first recorded contribution of a paper was not to the educational but to the Section of Geography in 1908, when he presented geography as "one of the most valuable subjects in a school curriculum", as providing not only intellectual discipline but also the human interest of "the most inspiring literature". This theme recurred incidentally in his finely phrased presidential address to the Education Section in 1922.

His presidency of the Association came in 1940, and was unique in having lasted for six years. During the War there were no annual meetings of the Association on the usual scale, but Gregory eagerly supported the conferences arranged in London by the Association's Division for the Social and International Relations of Science, of which at least one, that on "Science and World Order", which brought together not only British speakers but also foreigners of eminence who had found refuge in Britain, attracted attention far outside the meeting-hall, and indeed beyond the confines of science itself. Gregory's presidential address, too, was given in unique circumstances, the sole public pronouncement at a one-day meeting in 1946 held in the hall of the British Medical Association, since there had not been time to arrange an annual meeting on the full scale immediately after the end of the War. Whatever disappointment Gregory felt at not presiding over such a meeting was concealed in his readiness to serve the Association to the best advantage as judged by those who worked with him, by one of whom this tribute to his memory is gratefully contributed. O. J. R. Howarth

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Memorial Service

A memorial service for Sir Richard Gregory will be held in St. Martin-in-the-Fields Church, London, on Friday, October 3, at 12 noon.

NEWS and VIEWS

Henri Moissan (1852–1907)

Born in Paris a century ago, on September 28, 1852, Henri Moissan was appointed demonstrator at the École de Pharmacie, Paris, at the age of twenty-seven. After obtaining his doctorate in science in 1885, he became professor of toxicology in the following year, and professor of mineral chemistry in 1889. In 1900 he was called to the chair of chemistry at the Sorbonne. He is best known for having isolated and liquefied fluorine, for which he received the La Caze Prize of the Paris Academy of Sciences in 1887, and for his development of the electric furnace, which made possible the reduction of very refractory metals. His preparation in 1893 of minute artificial diamonds by extremely rapid cooling of a solution of carbon in molten iron created a great sensation at the time. He also simplified the production of acetylene. Moissan shared the Hofmann Medal of the German Chemical Society with Sir William Ramsay in 1903 and was awarded the Nobel Prize for Chemistry in 1906. His most important

books include "Le Four Electrique" (1897; English translation, 1904), and "Le Fluor et ses Composés" (1900). He died on February 21, 1907.

Inter-African Labour Institute

Miss Sheila Ann Ogilvie, at present assistant labour adviser to the Secretary of State for the Colonies, has been appointed the first director of the Inter-African Labour Institute, with headquarters at Bamako in the French Sudan. The Institute is to provide a permanent centre for the collection and distribution of information on labour problems in Africa, and is under the auspices of the Commission for Technical Co-operation in Africa, which was set up in 1950 by the Governments of Belgium, France, Portugal, Southern Rhodesia, the Union of South Africa and the United Kingdom to promote international technical co-operation in Africa south of the Sahara.

International Council for the Exploration of the Sea

Founded in Copenhagen on July 22, 1902, by Denmark, Finland, Germany, The Netherlands, Norway, Russia, Sweden and the United Kingdom, the International Council for the Exploration of the Sea is celebrating its jubilee by a meeting in Copenhagen during September 29–October 7. The Council was founded upon the initiative of Sweden, which in 1899 held a conference at Stockholm on international investigation of the sea; in 1901 a similar conference took place at Christiania (Oslo), followed by a meeting at Copenhagen in 1902, at which the Council was formed, its purpose being to promote practical scientific investigations of the food fishes, plankton and sea water, as a basis for international conventions aiming at securing a better output of the fisheries. The first president was Dr. W. Herwig (Germany), with the following national members of council: Otto Pettersson (Sweden), Dr. P. P. C. Hoek (The Netherlands), Capt. C. F. Drechsel (Denmark), Prof. Fridtjof Nansen (Norway), Dr. Oscar von Grimm (Russia) and Prof. D'Arcy Thompson (United Kingdom). The jubilee meeting will be attended by about two hundred delegates and guests from the member States of the Council, and observers and guests from the United States of America, Australia and Canada. The International Council itself consists of two government delegates appointed by each participating State, and it elects a president, a first vice-president and three vice-presidents who form the Bureau, which has always had its central office in the castle of Charlottenlund, Denmark. The present officers are: *President*, Dr. K. A. Andersson (Sweden); *First Vice-President*, Mr. A. T. A. Dobson (United Kingdom); *Vice-Presidents*, Mr. G. J. Lienesch (The Netherlands), Prof. Jean le Gall (France), and Dr. H. U. Sverdrup (Norway).

Royal Alfred Observatory, Mauritius: Report for 1950

The annual report for 1950 of the Royal Alfred Observatory, Mauritius (pp. 12; Govt. Printer, Port Louis; 1951; 25 cents) deals with the functions of the observatory department, which are meteorological and magnetic; the provision of meteorological services for government departments and all other purposes; and the organization of meteorological observations in the Colony of Mauritius and in its Dependencies, etc. Pilot balloon observations were made daily at the Observatory, and, when conditions were suitable, additional ascents were made at the islands of St. Brandon and Agalega. A description of tropical cyclones and cyclonic depressions during 1950 is given and also the data on the rainfall, which was 42·36 in.—83 per cent of the normal amount. The organization of returns from rainfall stations has resulted in returns from 157 of these, of which 130 made complete returns in 1950. This shows a marked improvement on 1948 and 1949, in which the returns were fifty-five and ninety-six, respectively. The Kew magnetometer was used to make forty-eight observations of declination and seventy-five of horizontal force, and forty-eight observations of dip were taken with the earth inductor. On August 9 determinations of the scale values of the horizontal-force and vertical-force magnetographs were made, the values obtained being 0·0000327 and 0·0000113 c.g.s. unit per mm., respectively. Tables show the principal magnetic storms during the year, the mean values of the magnetic elements, derived from hourly values, and also the changes in the mean values for 1949 and 1950. The staff of the Observatory includes a total of thirty-two in addition to the director, Mr. N. R. McCurdy. In spite of wide advertising, the two new posts of meteorologist and assistant meteorologist had not been filled at the time of printing the report.

Sectioned Model of the Earth in Manchester Museum

An account of a sectioned globe, which has recently been installed in the Manchester Museum, is contained in the May issue of the *Museums Journal*. The globe is 30 in. in diameter, and emphasis has been placed on data and the lines of evidence bearing on the earth's interior. Current theories are summarized, and a special constructional treatment is reserved for the evidence of earthquake waves. The core and inner core—revealed by earthquake waves—are made to project into the quadrant cut between the planes of the equator and Greenwich meridian. The colour of the globe is a compromise between a reflexion of the possible true colours of the earth's interior, and shades that are arresting and aesthetically satisfying.

Power Sources in Arid Zones

A meeting to discuss the development of sources of power in arid zones through wind and solar energy is to be held by the Advisory Committee on Arid Zone Research of the United Nations Educational, Scientific and Cultural Organization during September 29–October 1. The Committee will also consider other questions related to this field, including the setting up of an Arid Zone Development Centre. The meetings are to be held in the rooms of the Royal Society, London, W.1. The Advisory Committee on Arid Zone Research consists of the following members: Dr. Hassan Awad, secretary-general of the Royal Geographical Society, Egypt; Mr. Richard L. Boke, regional director of the Bureau of Reclamation for California; Dr. B. T. Dickson, liaison officer for the Executive Committee of the Commonwealth Scientific and Industrial Research Organization, Australia; Mr. A. N. Khosla, additional secretary to the Government of India at the Ministry of Irrigation and Power, New Delhi; Prof. Roberto Llamas, director of the National Institute of Biology, Chapultepec, Mexico; Prof. Joseph Peros, University of Paris; Prof. L. Picard, director of the Israeli Geological Institute; Dr. H. G. Thornton, head of the Soil Microbiology Department at the Rothamsted

Experimental Station at Harpenden, Herts; and Dr. Jacobo Zender, director-general of agriculture at the Ministry of Agriculture, Peru.

Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A number of Commonwealth Fund fellowships are again being offered by the Commonwealth Fund of New York (1 East 75th Street, New York 21) to British subjects, for advanced study and travel in the United States. All expenses of travel, study and living will be met, with some adjustment of stipends for married men with families. The fellowships, which are open to British men and women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *General:* twenty fellowships to graduates of a university in the United Kingdom of Great Britain and Northern Ireland. Candidates must be available in London for interview in March 1953; age, 23–35; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, less than 40; tenure, 6–12 months; applications by December 31. *Dominion Civil Service:* five fellowships to Civil servants in the Governments of Australia, New Zealand and South Africa; age, less than 40; tenure, 12–21 months; applications by December 31. *Colonial Civil Service:* two fellowships to Civil servants in the Governments of British Colonies, Protectorates and Trust Territories; age, less than 40; tenure, 6–12 months; applications by November 15. *Journalism:* three fellowships to journalists practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies:* four fellowships will be available to faculty members appointed to or holding posts in American studies in universities in the United Kingdom, candidates to be nominated by their universities; tenure, 4–12 months (these fellowships are not limited by previous study in the United States). Application forms and further details of these fellowships can be obtained in Britain through universities or government departments, or from the Warden, Commonwealth Fund, Harkness House, 35 Portman Square, London, W.1.

Nature Conservancy Research Studentships

The Nature Conservancy has made the following awards for 1952 of research studentships for post-graduate training in ecology, tenable for periods up to three years at the institutions indicated: *Botany*, B. N. Bowden (Lincoln College, Oxford), Miss B. Douglas (Freshwater Biological Association, Ferry House, near Ambleside), J. D. Lovis (University of Leeds), K. J. F. Park (King's College, Newcastle upon Tyne) and I. H. Rorison (University College, Oxford); *Zoology*, A. B. Acton (Keble College, Oxford), J. M. Cullen (Wadham College, Oxford), M. J. Davies (Exeter College, Oxford), and A. M. Jordan and D. H. Murphy (University of Durham); *Physiography*, D. H. Maling (University of Durham).

The Night Sky in October

Full moon occurs on Oct. 3d. 12h. 15m., U.T., and new moon on Oct. 18d. 22h. 42m. The following conjunctions with the moon take place: Oct. 6d. 10h., Jupiter 7° S.; Oct. 20d. 10h., Mercury 4° N.; Oct. 21d. 15h., Venus 4° N.; Oct. 24d. 11h., Mars 1° N. Mercury is too close to the sun during most of the month for favourable observation. Venus, an evening star, sets at 18h. 25m., 18h. 0m. and 17h. 50m. on October 1, 15 and 31, respectively. Its stellar magnitude is − 3·4, and 0·90–0·83 of the illuminated disk is visible. Mars is an evening star, setting at 20h. 10m. in the middle of October and only ten minutes later and earlier at the beginning and end of the month, respectively; the stellar magnitude varies between 0·6 and 0·8. Jupiter rises at 19h. 10m. on October 1 and about two hours earlier at the end of the month. Its stellar magnitude is − 2·4, and during October it is a little south of δ Arietis. Saturn is in conjunction with the sun on October 11 and is unfavourably placed during the month for observation. Occultations of stars brighter than magnitude 6 are as follows: Oct. 5d. 20h. 08·9m., μ Arie. (*R*); Oct. 6d. 21h. 53·5m., 17 Taur. (*D*); Oct. 6d. 22h. 10·6m., *q* Taur. (*D*); Oct. 6d. 22h. 18·4m., 20 Taur. (*D*); Oct 6d. 22h. 37·5m., 17 Taur. (*R*); Oct. 6d. 22h. 51·8m., 16 Taur. (*R*); Oct. 6d. 23h. 06·3m., *q* Taur. (*R*); Oct. 6d. 23h. 22·1m., 20 Taur. (*R*); Oct. 6d. 23h. 26·9m., 21 Taur. (*R*); Oct. 29d. 0h. 21·4m., 232 B.Aquar. *m* (*D*); Oct. 30d. 20h. 04·3m., 51 Pisc. (*D*). *D* and *R* refer to disappearance and reappearance, respectively, and observations are for Greenwich. The Orionid meteor shower occurs about October 20–23; the radiant of this shower is at R.A. 6h. 24m., dec. 15°. The supposed connexion between this stream and Halley's Comet has been disproved by the work of Prof. A. C. B. Lovell, of Manchester, who has shown from a determination of the velocity of meteors from the shower that the period must be comparatively short and hence the shower cannot be associated with Halley's Comet, the period of which is about 76 years. The same conclusion applies to the η Aquarids early in May, which were also believed to be associated with Halley's Comet.

Announcements

The sixth Rutherford Lecture of the Physical Society will be given on October 3 at 5.10 p.m. in the Lecture Theatre of the Science Museum, London, S.W.7, by Prof. R. E. Peierls, professor of theoretical physics in the University of Birmingham; he will speak on "The Atomic Nucleus and its Constituents".

At an open day which is being held at the Fulmer Research Institute, Stoke Poges, Bucks, on September 30, a memorial plaque to the founder, Colonel W. C. Devereux, will be unveiled by Lord Hives, of Rolls Royce, Ltd.

By an Order of the Committee of Privy Council for Medical Research, Sir Geoffrey Vickers has been appointed to be a member of the Medical Research Council. By the same Order made in this respect after consultation with the Medical Research Council and with the President of the Royal Society, the following have also been made members of the Council: Prof. G. R. Cameron, professor of morbid anatomy in University College Hospital Medical School, London; Prof. A. J. Lewis, professor of psychiatry in the University of London; and Sir James Spence, Nuffield professor of child health in the University of Durham.

EDUCATION OF THE DEAF

DURING the recent meeting of the British Association at Belfast, the session of the Education Section (L) on the morning of September 8 was devoted to three papers and a discussion on the education of the deaf. Mr. A. L. Binns, president of the Section, took the chair and there was a large attendance.

The first paper, by Sir Richard Paget, on "The Education of the Totally Deaf", was read in his absence by Mr. E. S. Greenaway, headmaster of the Yorkshire Residential School for the Deaf, Doncaster. Sir Richard put forward conclusions about the relationship between human speech and thought, the origins of speech and the possibilities of lip-reading. He reported that he and his collaborators had evolved a new language of manual signs. He recommended that this should be learned by the mothers of young children who were found to be totally deaf, and taught by them to their children, before speech.

In a second paper, Mr. R. Askew gave an account of the establishment, in 1946, of the first secondary grammar school for the deaf, the procedure adopted in selecting candidates for admission, usually at the age of 13 +, the curriculum and out-of-school activities, the social life of the school, and the educational achievements and range of careers followed by its pupils.

Lastly, Prof. A. W. G. Ewing (University of Manchester) presented a summary of the results of investigations into the capacity of very young deaf children to learn and comprehend speech through lip-reading, into variations in the mental abilities, aural histories and residual capacity to hear of pupils in special schools for the deaf and partially deaf, the use of hearing aids and the ages at which children are ascertained to be deaf. Prof. Ewing illustrated his paper by a short documentary film "Children learning to Lipread". This showed how parents learn to train their children to watch for speech and to understand it through lip-reading, by engaging them, informally, in activities appropriate to their ages and interests.

Sir Richard Paget said that the mentality of uneducated children who are totally deaf is "utterly primitive". Handicapped by wordlessness, they can copy the actions of others and learn the techniques of various trades, but they cannot originate and cannot think logically, because "logical thinking depends upon the rearrangement of 'units of thought', such as our words: but the units of thought of the uneducated deaf are so vague, diffuse and shapeless that they cannot be fitted together with any precision". Their minds work differently from ours; they are probably a million years behind the times.

There is a very close relation, Sir Richard said, between expression by manual pantomime and expression by the tongue, lips and other oral gestures which carry the meaning of human speech. The noises of speech are quite secondary. They carry the gestures. Speech without sound is an effective means of expression, although intelligible only to a good lip-reader. The 'secondary' noises which accompany speech express the emotional state of the speaker. There is what Charles Darwin called "some kind of sympathy" between the movements of man's hands and those of his mouth. Originally, primitive man (with a mentality probably similar to that of present-day uneducated deaf mutes) must have expressed his ideas by pantomime; but "without knowing it, his mouth mimicked his hands".

Oral methods of educating the deaf aim at making the deaf appear to be normal, for example, by good lip-reading, good articulation and a sufficient vocabulary to enable their pupils to carry on simple conversation. But speech and lip-reading are extremely difficult for all but the exceptionally gifted deaf. Successful lip-reading is dependent on good sight and a clear speaker. It is not practicable in large gatherings, such as at a cathedral service. Many of the claims that are made of the successful teaching of speech to the deaf have related to cases of residual hearing, or of deafness appearing after the deaf pupil has already learnt to speak. Only a relatively small percentage of the deaf is actually totally deaf.

Generalized pantomime, Sir Richard commented, is a blind alley, which ignores the use of words. The oralists have been right in condemning the use of natural sign language. With the collaboration of Prebendary Albert Smith, of the Royal Association in Aid of the Deaf and Dumb, and others, Sir Richard said he had evolved a "systematic sign language", in which each sign is the equivalent of a spoken word. He thought that if such a language were used in communicating with a young totally deaf child, as a hearing mother talks to her young deaf child, it is probable that this deaf child would pick up the signs as easily as a hearing child picks up words. In this way the deaf child might acquire a vocabulary of verbal signs which it would use at first in the place of spoken words. At present this vocabulary of the new sign language amounts to about 3,000 signs, of which 900 are designed for quite young children. The principal signs of the children's vocabulary have recently been filmed by the Wellcome Foundation. In 1948 Mr. Greenaway sent one of the oral teachers from his school to London to learn this children's vocabulary. She learned the 900 signs at the rate of 240 signs an hour. Her whole instruction period was only eight hours, and she demonstrated her knowledge by signing one of Edmond Dulac's Russian fairy stories, after going through it once with Sir Richard. A systematic sign language would be incomparably easier to acquire than any spoken language.

Mr. Greenaway said that he firmly believed the oral method of education to be basic for all deaf children. He is concerned about pupils who are taught orally, but unsuccessfully. He believed that research, in the use of hearing aids, for example, would open up many possibilities of better education for the deaf in the future. But "a deaf child who has failed at school has failed to live". Of twenty deaf boys and girls who had left his own school this year, one had gained admission to the Mary Hare Grammar School for the Deaf, three had attended courses of technical training outside the school for the deaf; before leaving, four others were certainly oral successes, and four more would probably be described as oral successes. He was concerned about the rest. He felt that for children like them something should be added to oralism.

In a short discussion which followed, it was suggested that signing, if encouraged in a school for the deaf, might become a substitute for ordinary language. Finger-spelling was suggested by one speaker as a chief method of education, and another speaker asked

if the introduction of a variety of methods would not create confusion in schools for the deaf.

Mr. R. Askew said that the Mary Hare Grammar School for the Deaf, which was first opened in 1946, with 44 pupils, now provides 75 places. It is wholly oral, like the two private schools for the deaf from which it took its roots and which it replaced as centres in which secondary education is available to the deaf. In describing the aims of the Mary Hare School, Mr. Askew quoted the late Sir Fred Clarke—"to liberate the intelligence of our pupils, in and through active membership of society"—in this case by the achievement of the pupils, although deaf, of capacity to participate in the hearing, talking society of the general community. To gain this, the pupils have to have confidence in their abilities, particularly their capacity to lip-read and in general knowledge, which they must be able to enrich by reading.

The procedure adopted for selecting candidates for admission is: (*a*) notification to local education authorities of the holding of an entrance examination, (*b*) a preliminary screening test, by written papers in English, general knowledge and arithmetic, taken by candidates in their schools, followed, in the cases of those who attained the required standard, by (*c*) a visit to the Mary Hare School, during which the history of each candidate is studied, in the light of reports from head teachers, tests to determine hearing loss, the results of performance tests of ability and a vocabulary test, and assessments of personal and social behaviour in which all members of the teaching staff participate. The mental testing is carried out with the collaboration of the Department of Education of the Deaf, University of Manchester. On admission, the pupils who were born deaf are from two to three years retarded in vocabulary.

Each school day begins with an assembly at which a hymn is sung, followed by half an hour during which speech training is provided to meet individual needs. Wearable hearing aids are used by many pupils. 'School subjects' are taken by specialist teachers. A weekly 'library period' is an important part of the curriculum of each form. Extra-curricular activities include community singing, free access to a studio for painting and drawing, athletics in which the pupils compete with those of schools and organizations for ordinary boys and girls, hobbies and pets, a pig club and a school magazine, managed by a committee of the pupils.

In 1949, of twelve candidates who sat for the School Certificate Examination, all were successful. Since that year a number of pupils have gained the General Certificate of Education (two at the higher level). This year two pupils are proceeding to universities, one with a State scholarship. Not all pupils are expected to take the General Certificate. The aim of a wider culture is more important. Former pupils follow a wide range of occupations; for example, one, an assistant in the pathological laboratory of a hospital, is now studying for a university degree, and another is a quantity surveyor. All are working happily side by side with ordinary people, who accept them as fellow-workers. Eleven former pupils are continuing their studies by correspondence courses.

The number of schools for the deaf in Britain presenting candidates for admission has grown from ten, in 1946, to twenty-six in 1952. The existence of the Mary Hare Grammar School appears to be an incentive to teachers of the deaf elsewhere, and their pupils, to aim at higher standards.

In answers to questions, Mr. Askew said that the Mary Hare School is staffed by seven fully qualified teachers of the deaf and two teachers who are working for a special qualification. Incentives are used to encourage pupils to rely solely on speech and lip-reading as a means of direct communication. The tendency of newcomers to resort to signs is "dying out".

Prof. Ewing's paper summarized developments in the educational treatment of deafness in children that have resulted from modern scientific research in Britain and the United States, and included references to investigations made in the Department of Education of the Deaf, University of Manchester, with financial support from the Medical Research Council and the Leverhulme Trustees. It has been found that the onset of dumbness, due to deafness, can be prevented in earliest infancy. Children of two years old have learnt to lip-read and begun to talk spontaneously, as a result of skilful training in their homes. This possibility was first discovered when the parents of a deaf girl, aged one year and two weeks, demonstrated that, under the guidance of Dr. I. R. Ewing, they had trained her to lip-read and respond by specific acts of behaviour to six different phrases spoken in a natural and conversational manner. She was one of more than thirty deaf children, whose ages ranged from twelve weeks to nearly three years, who had similar training during 1947. By the age of two and a half, some of them became able to understand, through lip-reading, a vocabulary of up to 500 words and phrases.

It has been shown that deafness can be effectively ascertained during even the earliest weeks of life. Special tests for this purpose, based on the results of a study of the ways in which ordinary children develop capacity to respond to sound, have been evolved.

Of 781 children referred by medical officers and otologists to the Department of Education for the Deaf, University of Manchester, during 1948–51, for tests and educational guidance, those of two years old form the largest age-group. A majority of the pupils who at present are admitted to schools or classes for the deaf or partially deaf have had their handicap since before the age of two years; but many cases of partial deafness and some of severe deafness are not ascertained until after the children's admission to ordinary schools.

Great variations have been found in the stages of linguistic development which have been reached by deaf and partially deaf children when first seen. Of 430 children referred before the age of five years, almost all used their voices purposefully and some, especially of those who had become deaf after the age of one year, had a certain amount of imperfect speech. Of 351 boys and girls of school age, a majority were already talking, although very often imperfectly. Fewer than five per cent of pupils in schools for the deaf are unable to hear any sound. Experiments have shown that hearing-aid equipment can be designed and constructed to enable children who are very severely deaf to hear speech to an extent that stimulates their linguistic development and facilitates their general education. Children who, without this equipment, cannot hear any sound of conversational speech, unless uttered within a distance of two inches from their ears, have learnt to combine skill in the use of hearing aids with proficiency in lip-reading. Investigations are in progress to find ways that are economically practicable for making school rooms

acoustically fit for the effective use of powerful hearing aids, and ways of modifying hearing aids to enable very young children who are severely deaf to benefit from continuous auditory experience.

During the course of a brief final discussion, Prof. Hallowell Davies, of Washington University, St. Louis, said that in the Central Institute for the Deaf, with which he is associated, it has been found that children who are admitted to the nursery unit, at an early age, are much less liable to linguistic retardation than those who enter school later. No 'signs' have ever been used in the Institute.

As a personal comment, the present writer regrets that the first paper at the meeting tended to focus attention on the use of 'signs' as a means of communication with the deaf, and to divert it from consideration of the outstanding success with which secondary education for the deaf has been established at the Mary Hare Grammar School, which is a unique institution of exceptional interest to educators and psychologists. A dictionary of organized signs, prepared by the Abbé Sicard, who published in 1823, still exists; its use was long attempted in France but was abandoned many years ago.

MEASUREMENT AND IMPORTANCE OF ELASTIC PROPERTIES OF METALS

A CONFERENCE was held at the National Physical Laboratory, Teddington, during March 20–21 on the "Measurement and Importance of the Elastic Properties of Metals", to discuss the measurements of elastic constants which have been going on in the Laboratory and elsewhere, and to consider how the information obtained from them could be used by metallurgists. It was attended by between eighty and ninety representatives from universities, industrial concerns and government departments. The first day was devoted mainly to describing experimental techniques and the results which have been obtained from them, while on the second day the speakers considered how elastic constant measurements could contribute to new knowledge of the physics of solid states.

The first paper was by Mr. A. F. C. Brown (National Physical Laboratory), on the "Static Measurement of Very Small Strains". He pointed out that in order to measure strain to an accuracy of ± 1 per cent it is often necessary to measure changes of length of less than 10^{-5} in. Even higher precision is needed if a study is being made of small variations in elastic constants, and great difficulty is experienced in transferring the strain to the extensometer without introducing significant errors. Generally, the most suitable methods are those in which the extension of a standard length of a specimen is made to rotate a mirror; but direct microscopic examination of length changes, and interferometer techniques, have also been used. It is very important to ensure that the desired type of loading is achieved, and this has been the subject of considerable research in the National Physical Laboratory.

In a paper on "Medium and High Frequency Measurements of Elasticity", Mr. G. Bradfield (National Physical Laboratory) described the methods in use at Teddington for the dynamic measurement of elastic constants, pointing out that, except at very high frequencies, the moduli vary somewhat with rate of straining. This was illustrated by results with polycrystalline aluminium from 0·4 c./s. to 50 kc./s. over a temperature range of 30°–700° K.

Methods using pulse-travel times and frequencies of 1–20 Mc./s. are very useful for measuring elastic constants of single crystals, and accuracies of a fraction of 1 per cent have been obtained with crystals of a few millimetres in size. On fine-grain polycrystalline bars about 10 cm. long, accuracies of 0·03 per cent are possible. Generally, the quartz crystal transducers used are mounted on steel or fused quartz blocks, which are applied to the specimen under test. Although separate transducers for transmitting and receiving have been most widely used at the National Physical Laboratory, many measurements with a single probe on both solid and liquid specimens have been made at high temperatures, and an attempt is being made to reach 1,550° C. in this way.

Of many alternative resonance methods, those using magnetostrictive transducers (which can produce both rotational and irrotational vibrations) are preferred, and have been used from near absolute zero to 500° C.; 1,000° C. is the probable limit with the present equipment. Inductor methods have been used for specimens weighing as little as ¼ gm. The best accuracy obtained by resonance techniques is a few parts in 10^4 in the elastic moduli.

For bars, the lateral inertia effect on velocity enables Poisson's ratio to be determined very accurately, and deviation from $(\frac{1}{2}E/G - 1)$ indicates anisotropy quantitatively, and thence the true constants for an isotropic material can be calculated, as described in the following paper.

Mr. H. Pursey and Mr. T. H. Schofield (National Physical Laboratory, Physics Division and Metallurgy Division, respectively) presented a paper on "Elastic Constant Measurements on Some Alloys". Measurements of the elastic moduli of a series of α-solid solutions of copper with elements of the first long period show principally a fall in modulus as the percentage of stranger atoms increases, and for a given atomic percentage of solute the higher the number of valency electrons the greater the depression in elastic moduli. They pointed out, nevertheless, that plotting elastic moduli against electron concentration does not bring the four curves together, and it is clear that they cannot be brought together by plotting against any power of electron concentration. Zener's theory of the misfit effect between solute and solvent atoms was outlined, but this too fails to explain the results satisfactorily. A further anomaly exists at very low atomic percentages, where it is found that the effect of introducing small amounts of stranger atoms is, in fact, to raise the moduli above those obtained for the pure metal. This may be due to the tendency of the foreign atoms to provide 'anchor points' for dislocations, thereby strengthening the material.

The remainder of the paper was devoted to an explanation of the mathematical technique whereby the elastic constants of an isotropic material may be derived from measurements on an anisotropic specimen of the same composition, assuming the anisotropy to be due to preferential orientation of grains, and that the lattice has cubic symmetry. The corrections are functions of the single-crystal constants, and proportional to the fractional difference between $(\frac{1}{2}E/G - 1)$ and Poisson's ratio as determined from the lateral inertia effect on longitudinal vibrations.

Since the functions vary slowly with the single-crystal constants, these need only be known to a relatively low degree of accuracy.

A discussion followed these papers, and in reply to a question by Dr. E. Billig, of Associated Electrical Industries, Ltd., Mr. Bradfield said that although propagation of waves up to 3,000 Mc./s. in solids has been reported, serious difficulty is likely to arise from scatter in polycrystalline materials. Replying to an inquiry, Mr. Bradfield said that the strains used in the resonance method were of the order of 5×10^{-7}.

The next paper was by Dr. E. G. Stanford (Aluminium Laboratories, Ltd.), and was entitled "The Variation of Young's Modulus of Aluminium Alloys with Temperature". He described measurements of the Young's modulus of aluminium by the resonance technique, using the fundamental mode of longitudinal vibration. The materials used were super-purity aluminium (99·992 per cent), commercially pure aluminium (99·5 per cent), an aluminium–manganese alloy (1¼ per cent manganese) and an alloy of the duralumin type. The specimens were subjected to heating and cooling processes, the rate of change of temperature being about 2° C. per minute, and measurements of Young's modulus were taken at intervals of 10° C. between room temperature and the melting points.

The results show a discontinuity in the Young's modulus/temperature curves at the recrystallization temperature, accompanied by an increase in internal friction. Precipitation from solid solution also causes a slight discontinuity for alloys which show age-hardening characteristics. The modulus of both the pure material and the alloys is generally decreased by cold work, and cannot always be made to recover by annealing. Recovery did not occur, for example, in the case of annealed super-purity material which had been strained 10 per cent in tension; however, when recovery does take place, it is greater in the case of the super-pure than in the commercially pure material. At 10 kc./s., relaxation occurs at a temperature of about 500° C. in the super-pure material, accompanied by an increase in internal friction. No such effects were observed at any temperature up to the melting point in the case of the impure materials. Dr. Stanford hoped that further work on the behaviour of alloys near their melting points would enable improvements to be made in casting techniques.

The final paper of the first day was by Prof. N. F. Mott (University of Bristol). He discussed the effect of temperature on the elastic modulus. The drop in the shear modulus is due partly to thermal expansion, there being no first-order change of entropy with shear, and hence no change of temperature on shearing. Some theoretical calculations have been made by Prof. Max Born's school for solid rare gases, but none for metals. He also discussed the effect of cold-work on the elastic modulus. He considered that a drop in the shear modulus of five to ten per cent is to be expected, and that this is due to the screw dislocations trapped in the lattice and not to the edge dislocations, the latter probably forming sessile (immobile) groups, for example, in deformation bands. The partial recovery of the elastic moduli after a low-temperature anneal, observed recently by A. D. N. Smith, should be due (like cross slip) to the mutual annihilation of screw dislocations, and a similar dependence on temperature is to be expected.

The morning session of the second day opened with a paper entitled "Theory of the Elastic Constants of Metallic Crystals" by Prof. H. Jones (Imperial College of Science and Technology, London), who explained that on modern electron theory the cohesive energy of metals may be regarded as arising from: (*a*) the exchange interaction between the ionic shells, (*b*) the energy of the lowest state of the conduction electrons (spherical approximation), (*c*) a correction to (*b*), the electrostatic potential term, and (*d*) the Fermi energy of all the conduction electrons. Since in different metals these terms have differing relative importance and variation with strain, it is now becoming possible, by comparing theory and experiment, to understand the dominant effects in the elastic constants of a particular metal or alloy. For example, where the ion radius is considerably less than the atomic radius, as in sodium, the term (*a*) will be small and the electrostatic contributions predominate. These are very anisotropic and hence in accord with the observed elastic constants of sodium.

The effect of strain on the Fermi energy can be illustrated by considering shearing distortion of the first Brillouin zone in the face-centred cubic case. If there is only one electron per atom, the Fermi surface is well within the zone and is little altered by shear; but if there are 1·5 electrons per atom, the surface touches the zone, and shear causes a tendency of electrons to leave the zone. The larger the surface of contact the greater is the change in energy and hence the greater contribution to the elastic constants. Some results on β-brass in general accord with these ideas were then described. Prof. Jones pointed out that the treatment is most satisfactory for atoms where there are clearly marked closed shells and few valency electrons, such as copper, silver, gold, sodium, magnesium; in conclusion, he emphasized the need for experimental observations from single crystals.

In the subsequent discussion, Prof. Mott asked if there is any connexion between elastic constants and the diamagnetic effects at low temperature in aluminium and bismuth associated with small groups of electrons overlapping the zones. Prof. Jones replied that in any metal the Fermi surface is very complicated, and the diamagnetic effects are considered to arise from small parts of the surface of very high curvature, whereas the elastic constants are associated with large overlapping. In answer to a question by Prof. J. D. Bernal, Prof. Jones agreed that he would expect interesting differences between the hexagonal metals of long and short axial ratio, for example, magnesium and zinc, and would value some experimental observations. In particular, the measurements should be made at different temperatures in order to give an idea of the absolute zero values. This is important, since it enables some elimination of the influence of temperature and internal strain on the elastic constants, for internal strain has an effect decreasing with temperature. Dr. R. Street (University of Nottingham) mentioned that there is a considerable change in Young's modulus in passing through the Curie temperature, and in reply Prof. Jones said that he felt the present treatment could give no satisfactory explanation of this effect.

Dr. W. A. Wooster (University of Cambridge) spoke on "Diffuse X-ray Reflexions from Crystals in Relation to Elasticity and Structure". Dr. Wooster outlined the fundamental principle that perturbations in the atomic lattice produce additional diffuse reflexions between the normal spots on a Laue pattern. Alternatively, with monochromatic radiation the diffuse reflexions are observed when the

crystal is rotated a small angle from the correct Bragg setting, that is to say, there is a spread of the reciprocal lattice points. By studying the diffuse reflexions near a particular point, attention is fixed on the thermal elastic waves of particular wave-length and wave-normal. From measurements of intensity the velocity of the waves can be derived and hence the elastic constants.

There are two main experimental methods: recording the reflexions on a photographic plate and using a microphotometer, or direct measurement of the intensities with a Geiger–Müller counter spectrometer. The former is less accurate, about ± 5 per cent, but has the advantage of showing the pattern of the reflexions. The Geiger–Müller method requires more elaborate equipment, namely, a highly stabilized X-ray source or a monitoring system, but can give an accuracy of about ± 3 per cent. Absolute measurements of the intensity of the X-ray beam, necessary if absolute values of the elastic constants are required, are less accurate (probably ± 10 per cent) owing to the difficulty of comparing the diffuse reflexions with a direct beam some 10^6 times stronger. The essential difference between this and all previous methods of measuring elastic constants is that the crystal is subjected to no external mechanical stress whatsoever. The constants, moreover, refer to very high frequencies, that is, wave-lengths in the region 0–200 A. There are few results yet obtained on metallic substances, the most important being those of Ohlmer on aluminium, who found marked dispersion for wave-lengths below about 10 A.

Dr. R. S. Leigh (Imperial College of Science and Technology, London) spoke on "Relations between Elastic Constants and Phase Boundaries in Alloys". Dr. Leigh explained that the free energy, F, of an alloy can be expressed as $F = E_0 + (E_v - TS_v) - TS_m$, where E_0 is the electronic energy at absolute zero; $(E_v - TS_v)$ is the lattice vibration term, E_v being the internal energy and S_v the entropy; and S_m is the mixing entropy in the case of a disordered solid solution. The equilibrium state of the alloy at a given temperature is, of course, that state which has the lowest free energy. An example of a theory based on the effect of lattice vibrations is that of Zener explaining the V-shaped phase boundaries of disordered body-centred cubic β-phases. This requires that the β-phase should have a lower Debye temperature than neighbouring phases. Zener has suggested that this is due to repulsive ion–ion interaction which in turn leads to a low value of $\frac{1}{2}(C_{11}-C_{12})$, a low cut-off frequency in the Debye treatment and hence a low characteristic temperature.

Considering the aluminium–zinc system, the solubility gap implies that here the mixture of the α- and α′-face-centred cubic structures has a lower free energy than an equivalent homogeneous phase. Thus the free-energy curve must be such as to have a common tangent at two points. The theory put forward to explain this is based on the idea of shearing the Brillouin zone, the overlapping electrons giving a negative contribution to the shear constant. The calculation leads to phase boundaries of the gap at 275° C. of 20 and 70 atomic per cent in comparison with observed values of 16 and 59 per cent. In conclusion, Dr. Leigh stressed the value of elastic constant measurements on single crystals, in particular in this field on solid solutions of aluminium with zinc, silver, lithium and magnesium.

The afternoon opened with a paper by Prof. C. S. Barrett (University of Birmingham), in which he discussed the after-effects in metals following plastic deformation and showed that they depend on the time occupied by the stress-cycle. He explained the after-effects in terms of anchoring and release of dislocations in the material. In discussion, it was pointed out that recent work at Bristol, in which care was taken to ensure that a homogeneous stress system was obtained, confirmed Prof. Barrett's views.

In the final paper, Mr. H. L. Cox (National Physical Laboratory) referred to the general issue of stability. He stated that failure by structural instability within the elastic range is always a possibility, and that it is quite easy to devise laboratory models which would collapse in this way under any prescribed form of loading; until the nature of the true forces of cohesion within a solid material is better understood, the possibility that the strength of the material is limited by elastic instability should not be overlooked.

After a short discussion, Dr. N. P. Allen, in closing the conference, expressed the hope that the National Physical Laboratory would have similar opportunities in the future for bringing the results of specialized research into closer relation with technological interests.

STANDARDS OF LIFE IN LESS-DEVELOPED AREAS

TWENTY years or so ago, the number of surveys of living conditions carried out each year in the 'less-developed' as well as in the 'more-developed' countries began to increase rapidly, reaching its peak just before the Second World War. This was, of course, due in the first instance to efforts on the part of administrative agencies to collect information on the basis of which action could be taken to combat the consequences of the economic depression—or sometimes, perhaps, to justify a reluctance to discharge responsibilities of this kind. A large amount of information has thus been made available as a by-product of government activity, rather than as a result of scientific research properly so called. The reports in which this information is presented have been collected by the United Nations Department of Social Affairs*, and an opportunity has now arisen to see what they amount to, and to evaluate their reliability.

The task is an important one, partly because of the urgent need for dealing with the problems of poverty and squalor in the less-developed countries, and partly because it is high time that administrative agencies so plan their work as to make available as much raw material as possible for scientific research. The range of social problems in the international field is so vast that it is unlikely that *ad hoc* researches can be undertaken to throw light on them. The proper planning of national and local surveys to secure comparability of the results is therefore an obvious necessity.

The first report which the Department of Social Affairs has published in the series dealing with inquiries into household standards of living in less-developed areas surveys the organization and geographic and demographic range of field-investiga-

* United Nations. Enquiries into Household Standards of Living in Less-Developed Areas: a Survey of the Organization and Geographic and Demographic Range of Field Investigations of the Income, Expenditure and Food Consumption of Selected Households in Africa, Asia, the Caribbean, Latin America and the Pacific. Pp. viii+191. (New York: United Nations; London: H.M. Stationery Office, 1951.) 2 dollars; 15*s*.

tions of the income, expenditure and food consumption of households in Africa, Asia, the Caribbean, Latin America, and the Pacific. It is issued as the first part of a Survey of which the ultimate aim is "to provide a critical commentary on such information on standards of living in the less-developed areas of the world as is at present available". This is a task that is as ambitious as it is praiseworthy, for as the information available from the inquiries that are surveyed is narrow both in its range and its scope, the Survey will perforce "constitute a study of the limitations rather than of the extensiveness of the data now available".

This statement must be somewhat depressing to those whose interest in living conditions is administrative rather than scientific; something more might have been hoped from a study of twenty years of work in this field, because the aspects of the conditions which are dealt with by the Survey (consumer income and expenditure and domestic food consumption) are those concerning which it is most easy to produce quantitative data. The first volume of the Survey, however, makes it plain that the inquiries so far conducted are seriously defective in many respects. In the first place, the households which are the subjects of the investigations have almost invariably been selected from the members of social, economic or occupational population groups, the majority living in single localities. As a result, the geographical range of the strict applicability of the findings is narrow, often being confined to the locality concerned; few instances of comparability between inquiries conducted within the same territory have been found, and virtually no instances at all of direct comparability between inquiries conducted in different countries or territories. The general conclusion on this score is that, although the areas in which the inquiries were conducted are widely dispersed, they constitute "a relatively insignificant fraction of the total inhabited surface of the less-developed portion of the world", and, "in most cases, of particular less-developed countries or territories".

The inquiries are also defective in a rather more technical sense. Few even of the relatively small number of inquiries which, it is claimed, deal with an adequate representative sample of the relevant statistical universe, appear to be free from faulty selection procedures, or from a failure to apply the sampling procedures originally decided on when a survey was being planned. "In many cases," it is said, "the methods applied to the choice of the units of investigation either deviated from the target standards of selection, or were not calculated to secure an unbiased choice." The final conclusion embodied in the first volume of the Survey is therefore that "both in respect of the less-developed countries and territories as a whole, and in respect of them individually, the total amount of information available on household income and expenditure and domestic food consumption is, if not negligible, at any rate meagre".

This is not to say, of course, that the work carried out hitherto has been a waste of time for administrative purposes. The statistician may be very sceptical about the results of numerous surveys of the condition of half a dozen or even single households. It is obviously dangerous to base sweeping generalizations on the circumstances, for example, of five families who are thought to be "more or less typical of the average run of Punjab cultivators working between seven and sixteen acres of land each", or on those of two families at San Antonio Huichimal, Mexico. Nevertheless, crude information such as this may be found to vary from case to case only within narrow margins, and to present a picture of basic poverty which is of great political and administrative significance. As is said in the first volume of the Survey, therefore, "in a socially and economically homogeneous environment, data on the living conditions of a small number of judiciously, albeit not statistically, selected households, or even of a single typical household, cannot but be an expression of the domestic economies and material circumstances of life of the community as a whole".

In sum, then, even though the Survey demonstrates the need for greatly improved techniques in social surveys conducted in underdeveloped countries, the information elucidated in this way is of great interest, and the "critical commentary" on it which the Survey will produce will be received with gratitude both by social scientists and by administrators.

ELECTROMETRIC DETERMINATION OF OZONE AT HIGH DILUTIONS

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THE chemical reactions which were formerly mainly employed for the estimation of ozone were based on the liberation of iodine from a neutral potassium iodide solution[1]. In the absence of any more accurate or sensitive method, a check on the assumed reaction was lacking, and it is now apparent that this simple procedure is of value only for conducting comparative measurements. On the other hand, the precise spectrophotometric technique[2] which has now been developed and extensively employed in atmospheric tests is difficult to apply in isolated districts and is limited to the measurement of a column of air several kilometres in length.

Extended laboratory trials by us have shown that an electrometric technique provides a highly sensitive method which could be applied to the determination of local atmospheric concentrations by means of a readily portable apparatus. For this purpose a measurement is made of the E.M.F. of a suitable oxidation-reduction system which is determined by the well-known relation:

$$E = \frac{RT}{nF} \ln\left(k \frac{[\text{oxidant}]}{[\text{reductant}]}\right) = E_0 + \frac{RT}{nF} \ln\left(\frac{[\text{oxidant}]}{[\text{reductant}]}\right),$$

where k is the equilibrium constant of the reaction, E the potential with a given solution, and E_0 the potential with a solution containing equal concentrations of oxidant and reductant.

Of different reactions which were investigated, the one most suitable and specific for ozone was found to consist of the oxidation of hydrobromic acid with liberation of bromine in accordance with the reaction: $O_3 + 2\ H^+ + 2\ Br' \rightarrow Br_2 + H_2O + O_2$. (At atmospheric pressure and a temperature of 18° C. the E.M.F. of ozone against hydrogen is estimated at 1·9 volts, and that of bromine in a normal solution of bromine ions at 1·066 V.)

The electromotive equation with this reaction takes the form:

$$E = E_0 + \frac{RT}{nF} \ln\left(\frac{[Br_2]}{[Br']}\right) = E_0 + 0{\cdot}029 \log\left(\frac{[Br_2]}{[Br']}\right)$$

at 18° C. The cell, employing the usual arrangement for this type of measurement, consisted of:

+ Pt wire	$3N$ H_2SO_4 $1N$ KBr	$3N$ H_2SO_4 saturated with Hg_2SO_4	— Hg

On passing ozonized air through the left-hand half-cell, the resulting potential is not proportional to the volume passed but approaches a limiting value depending on the concentration of ozone, due to the liberated bromine only accumulating until its rates of formation and vaporization are equal. With a stream of air free from ozone, the potential of the above system ranged, in different experiments, from 0·050 to 0·070 V., the variation arising from the response to the sensitive logarithmic effect of traces of free bromine.

For the standardization of this method, air with various contents of ozone was prepared by admixture with the anodic gas liberated from the electrolysis of sulphuric acid solution. The ozone contents were determined by passing a definite quantity through potassium iodide solution, acidifying and titrating the liberated iodine with $N/1{,}000$ sodium thiosulphate, a correction being applied for the amount of iodine liberated by oxygen in a blank experiment. The end-point of the titration was determined electrometrically from the oxidation potential. Air of ozone content as thus determined was then passed through the reagent surrounding the platinum wire until the E.M.F. attained an equilibrium value and became constant. The main precautions which it was found necessary to observe are: (1) to complete the purification of the sulphuric acid used by subjecting it to a stream of strongly ozonized air; (2) to introduce in the reagent initially a small amount of bromine by adding a little potassium bromate and then eliminating the bromine by heating on a water-bath to about 90° C.—alternatively a small amount of bromine can be allowed to remain so that the equilibrium value later given by the ozonized air can be approached from the higher value of the E.M.F. thus resulting; (3) the use of mercury to be avoided to make contact with the platinum wire electrode in its glass support; (4) to prevent access to the inner walls of the tube by the reagent into which the gas is led.

Typical laboratory measurements with this cell gave the following results:

Ozone (parts by volume per 10^6 of air)	Final E.M.F., corrected to 21° C.
13·3	0·237 V.
3·5	0·221
1·62	0·206
0·52	0·185
0·20	0·169
0·11	0·154
0·07	0·135
0·055	0·108
0·045	0·079

The circulation of oxygen or ozone-free air was found not to affect the E.M.F. values given, and nitrogen peroxide only caused a displacement if the concentration exceeded 10^{-6}. It is seen from these results that, when employing concentrations of ozone down to about 2 parts in 10^7 of air, the relationship between ozone concentration and potential was approximately in accordance with the following numerical values for the above equation, $E = 0{\cdot}1995 + 0{\cdot}0355 \log [O_3]$ (ozone concentration is in parts by volume per 10^6 of air), in place of the theoretical coefficient of 0·029. The discrepancy is probably due to the chemical method for estimating the ozone, which fails still further for concentrations below 10^{-7}. The results have shown the high degree of sensitiveness of this method, but no check on the applicability of the formula given has yet been possible. The instability of ozone prevents the preparation and maintenance of supplies of known very low concentrations for the purpose of calibration.

Further trials with this hitherto unpublished method have awaited the development of some alternative accurate procedure, and it is hoped that the present note may merit consideration by those engaged in this field.

[1] Cf. Pring, J. N., *Proc. Roy. Soc.*, A, **90**, 204 (1914).
[2] Cf. Dobson, G. M. B., *et al.*, *Proc. Roy. Soc.*, A, **110**, 660 (1926), *et seq.*

ABDOMINAL MECHANO-RECEPTORS IN *DYTISCUS* AND *LOCUSTA*

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DURING an investigation of the nervous control of respiratory movements in the water beetle *Dytiscus marginalis*, electrophysiological evidence has been obtained for the existence of sense organs responsive to these movements. The abdominal movements consist of an active expiratory phase in which the tergites are depressed by contraction of segmental sterno-tergal muscles, and a passive inspiratory phase in which these muscles relax. These movements normally occur 10–15 times per min., but the frequency may be only 6 per min. after dissection of the abdomen.

Electrical activity in the segmental nerves and abdominal ganglia has been recorded simultaneously with the dorso-ventral movements of the abdomen under various conditions. The normal response in the mixed nerves is composed of groups of large motor spikes and smaller sensory ones. The respiratory movements usually persist after severing a single nerve, and activity in sensory fibres can then be recorded from the distal section of the nerve. The activity in single afferent fibres has been studied and several responses similar to those recorded from the mammalian vagus[1] have been observed. These are apparently due to:

(1) End organs from which the frequency of impulses increases during inspiration. The discharge is usually irregular between successive ventilation movements but may become extremely regular (70 per sec.) at the onset of inspiration.

(2) End organs from which the frequency of impulses increases during both inspiration and expiration (Fig. 1). Expiration is commonly succeeded by a silent period before the resumption of an irregular resting discharge.

(3) End organs from which a persistent discharge of impulses is inhibited during inspiration. The resting discharge may cease completely and re-commence with a burst of high frequency at expiration.

Responses of the first two types may be found in nearly all preparations; but type (3) is of less frequent occurrence. No constant relationship has been observed between the nerve or segment and the type of response.

It was of considerable interest to find that responses to low-frequency vibrations could also be recorded from these nerves. Preparations are very sensitive to tapping of the substratum and to whistling in a low register. Such responses to ground and airborne vibrations are usually obtained from end organs that are not responding to the regular breathing movements, and many of the responses to the latter are not interrupted by these stimuli. When excited by pure tones in a sound-proof room, these receptors are found to be sharply tuned to frequencies of about 100 c./sec. The frequency of nerve impulses bears no relation to the frequency of the sound waves but increases as the intensity is raised (Fig. 2*a*). At a given intensity the frequency of discharge in a single fibre remains relatively constant (Fig. 2*b*). Similar observations led Pumphrey[2] to suppose that responses recorded from segmental abdominal nerves of the locust were probably from chordotonal organs and not from auditory hairs as suggested by Pumphrey and Rawdon-Smith[3]. The responses which they recorded were to sounds in the neighbourhood of 1,400 c./sec.

These auditory responses in the locust have been confirmed, and in addition bursts of impulses have been recorded from the segmental nerves during the inspiratory and expiratory movements. Some end organs respond to both the respiratory movements and auditory stimulation, while others are excited by either one or the other.

The precise nature of the receptors involved in these responses is not yet clear. The abdominal cuticle of *Dytiscus* is well supplied with sensory hairs and spines of several types[4], and there are also segmental chordotonal organs similar to those described in the larvæ by Graber[5]. Methylene blue staining has assisted in tracing the branches of nerves from which breathing responses had been recorded, and it has been found that these nerves contain fibres from the segmental chordotonal organs. The structure and position of chordotonal organs has long led morphologists to suppose that they have a proprioceptive function[6]; but little experimental evidence has been adduced for this view. It is generally accepted that chordotonal organs may have an auditory function[2]; and some of the evidence that responses to such stimulation are detected by segmental organs in *Dytiscus* and *Locusta* has been summarized above. There is no *a priori* reason why both sorts of response should not come from end organs of this type, as it has been generally recognized that from a functional

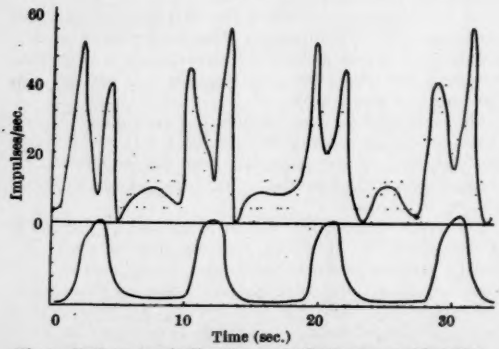

Fig. 1. *Dytiscus marginalis*. Changes in the frequency of impulses recorded from a single afferent fibre in a segmental abdominal nerve. The rhythm of ventilation movements is shown below (expiration upwards)

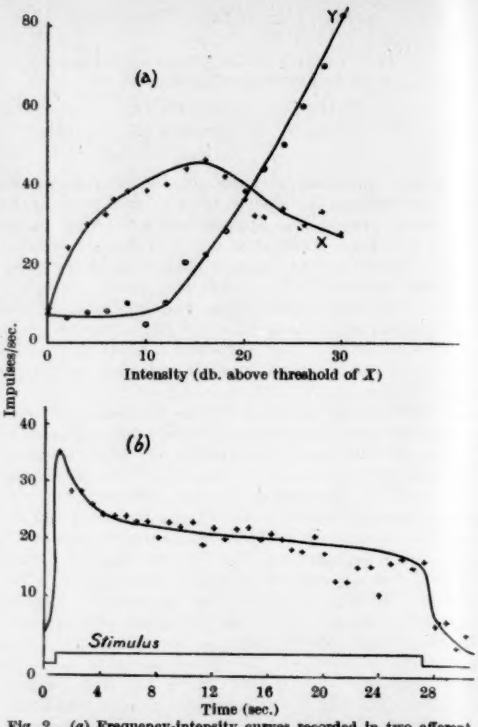

Fig. 2. (*a*) Frequency-intensity curves recorded in two afferent fibres of abdominal nerves in response to sine-wave stimulation at 100 c./sec. (*b*) Curve showing gradual decline in frequency of impulses in fibre *X* during continuous sine-wave stimulation at 100 c./sec.

point of view this class of sense organs is not as homogeneous as it is morphologically. It is not improbable that different types of chordotonal organs have become differentiated in a way analogous to the receptors of the vertebrate acoustico-lateralis system[7,8].

Whatever the nature of the end organs involved, the responses from the abdominal nerves of *Dytiscus* demonstrate that this insect possesses the sensory equipment to detect sounds of frequencies about 100 c./sec. The flight of these insects in response to sounds and on the approach of footsteps is well known[5]. Furthermore, the responses to the ventilating movements may be of importance in the nervous co-ordination of these movements and may modify the activity of respiratory centres[9,10] which have been suggested in these insects. Such a function is in accord with Eggers's supposition that chordotonal organs may function as 'rhythmometers' which co-ordinate and regulate the rhythmical movements of respiration, circulation and locomotion.

Further results of this work will be published in more detail elsewhere. [March 17.

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LETTERS TO THE EDITORS

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Internal Fissuring of Wheat due to Weathering

RADIOGRAPHIC technique developed at this Station for the determination of internal or hidden insect infestation in stored grain[1] has proved to be useful for the detection of other physical anomalies in grains. Practical applications of this sort include the detection of cracked or broken kernels in rough rice (paddy) prior to milling[2] as well as the extent of internal fracturing of certain grains such as maize due to uneven stresses arising from severe drying conditions. This communication deals with a condition of internal fissuring occurring in wheat due to weathering of the ripened grain in the field.

Examination of radiographs of numerous samples of non-infested wheat disclosed that some had the appearance shown in Fig. 1, indicative of sound, normally matured grain, while others produced fine radiographic shadows indicating the existence of cracks or fissures oriented at right angles to the longitudinal axis of the kernel (Fig. 2). (The pictures are projection prints of the original radiographs.) Close visual examination of both kinds of grain revealed that those samples which exhibited the fissuring were weathered, whereas the sound grain was of normal colour and bright in appearance. Weathered grain loses this sheen and colour, and the kernels present a faded and roughened appearance. This condition is known to be caused by wetting of the mature grain by rain as it stands in the field prior to harvest.

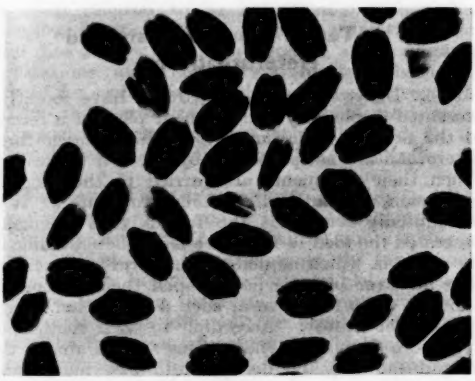

Fig. 1

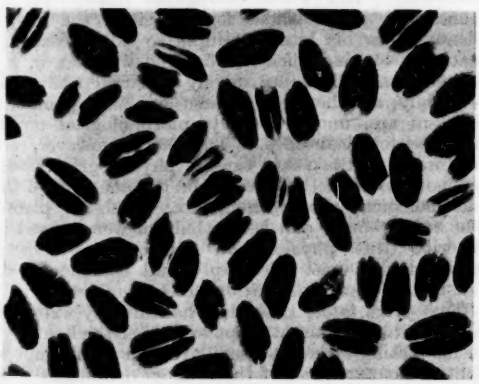

Fig. 2

It is well known that weathered or 'bleached' wheat kernels suffer a decrease in density associated with the swelling caused by wetting of the grain and that this change is not entirely reversible by subsequent drying in the field. This permanent loss in density is related also to the severity and frequency of wetting. It was at one time proposed[3] that this loss in density of grain, which has swelled by wetting and then has been re-dried, may be due to the formation of internal spaces in the endosperm of the grains. The present discovery confirms this hypothesis strikingly. The internally fissured condition has been noted not only in weathered hard red winter wheats from Kansas but also in spring wheats from North Dakota and western Canada.

These observations have prompted laboratory studies to determine precisely the conditions of wetting and drying which cause the fissuring of wheat to occur, as well as the effect of such fissuring on those physical characteristics of the grain which would affect its technological properties. The results of these studies will be published elsewhere.

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Rostral Extremities of the Sympathetic Trunks

THE older anatomists believed that the sympathetic trunks were attached to various cranial nerves; but nowadays the conception that they commence above in the superior cervical ganglia is apparently unquestioned, and the internal carotid nerves are described as branches of distribution of these ganglia. Is this modern view correct, or do the trunks really proceed farther in a rostral direction? They probably do, although not in the manner or position indicated by the classical authors. One suggests that the internal carotid nerves are cephalic portions of the sympathetic trunks, and the evidence in favour of this idea will be summarized here and given in detail elsewhere.

The internal carotid nerves, in man and other mammals, are often as thick as, or thicker than, the trunks uniting the superior and middle cervical ganglia, and appear to be direct upward continuations of the trunks into the carotid canals. A more significant feature is the occasional finding of macroscopic ganglia on these nerves, and the constant occurrence of discrete, microscopic collections of ganglion cells within them. These facts, and the morphological position of these nerves ventral to the costal vertebral elements, suggest that they are not purely branches of distribution of the superior cervical

ganglia, but are cephalic continuations of the sympathetic trunks. The discrete collections of cells may represent the sympathetic trunk ganglia of the primitive head segments, which have become telescoped and fused in man in the chordal part of the skull base, although evidence of segmentation still persists in the myotomes, branchial arches and mode of innervation. If this conception is correct, the interconnexions between the internal carotid and various cranial nerves arise in part from cells within the former, and they are homologous with rami communicantes arising from other parts of the sympathetic trunks.

Attempts to determine the exact nature, origin and course of the fibres in the internal carotid nerves by histological methods produce equivocal results, because the calibre, staining reactions and degree of myelination are not absolute guides to their character, and attempts to trace fibres in serial sections through the ganglionic maze of axons and dendrites have so far been unsuccessful. For reasons given later, experimental attempts to discover the origin and course of the fibres are hedged around with unusual difficulties.

Theoretically, preganglionic fibres could reach the internal carotid ganglia either from the thoracolumbar or cranial autonomic outflows, the latter through known and unknown interconnexions with various cranial nerves. Or fibres from both sources could reach the ganglia, and then they would be mixed sympathetic and parasympathetic structures; this possibility should not be dismissed because it is novel or conflicts with current opinions. It is customary to repeat, for example, that the sympathetic outflow is entirely thoracolumbar and that all preganglionic sympathetic fibres for the head end travel upwards in the cervical sympathetic trunks. Although the argument will not be elaborated here, it is doubtful if either statement is correct. The sympathetic outflow is predominantly thoracolumbar, but smaller numbers of preganglionic fibres emerge through other spinal nerves, and some of these may reach the superior cervical or internal carotid ganglia via upper cervical rami communicantes. Moreover, there is little doubt that a proportion of the sympathetic fibres for the head end run in the vertebral and other paravascular nerves. Thus preganglionic fibres could reach the internal carotid ganglia through the sympathetic trunks, the upper cervical rami communicantes, in paravascular nerves (vertebral, ascending cervical and pharyngeal, etc.) or through interconnexions with various cranial nerves.

Bearing all these potential routes in mind, it is practically impossible to devise experimental procedures to eliminate every alternative and provide adequate controls, and many mistakes have been made because of the failure to appreciate the existence of the less obvious pathways mentioned. Unilateral section of the sympathetic trunk below the superior cervical ganglion, with subsequent comparison after an appropriate interval of the internal carotid nerves of both sides, will not prove conclusively whether preganglionic fibres pass into these nerves: such fibres reaching the superior cervical or internal carotid ganglia through other channels would persist unchanged after the experimental trunk section and would vitiate the results. However, the gradual diminution in size of the internal carotid nerves from below upwards does indicate that the majority of the fibres are flowing in a cephalic direction from the sympathetic outflow.

By analogy, one other feature lends support to the view that the internal carotid nerves are cephalic portions of the sympathetic trunks. A ganglion (of Ribes) has been described alongside the anterior communicating artery, and it is known that filaments from the opposite internal carotid nerves extend along this vessel. One has found only microscopic collections of ganglion cells in this situation in man, but a macroscopic nodule was detected in one rhesus monkey and was proved histologically to be a ganglion. Perhaps the rostral extremities of the sympathetic trunks coalesce in this region, the site of union being indicated by a cranial ganglion impar. The resemblance of this to the caudal arrangement of the sympathetic trunks needs no emphasis.

To summarize: the true rostral extremities of the sympathetic trunks may unite around the anterior communicating artery in a cranial ganglion impar, and the internal carotid nerves, with their discrete groups of ganglion cells, may be the cephalic portions of the sympathetic trunks and not merely branches of distribution of the superior cervical ganglia.

The expenses of this investigation were defrayed with the aid of a grant from the Nuffield Foundation.

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The Terms Homothallism and Heterothallism

F. L. Drayton and J. W. Groves have recently[1] presented a scholarly and eloquent plea for a return to the original definitions of the terms homo- and heterothallism as proposed by A. F. Blakeslee[2]. When their arguments are carried to their logical conclusion, the authors are forced to admit: "It is undoubtedly true that the fungus that originally suggested the idea to Blakeslee is not heterothallic in the sense in which he defined the term". I contend that an error in logic has escaped these authors in allowing them to arrive at such a conclusion.

Blakeslee wrote[2]: "According to their method of zygospore formation, the various species among the Mucorineae may be divided into two main categories, which may be designated as *homothallic* and *heterothallic*, and which correspond respectively to monœcious and dicœcious forms among the higher plants". In his later attempts to homologize the mating reactions which he observed with sex in the higher plants, Blakeslee merely obscured what was, originally, a rather neat distinction. Monœcism and dicœcism are, unquestionably, morphological terms, not physiological ones. The facts, however, are irrefutable: Blakeslee saw a physiological phenomenon, which he believed to be the analogue of the morphological phenomenon, sex, in higher plants. The terms homo- and heterothallism were coined to describe this physiological phenomenon, not a morphological one. To imply that the mucors do not fit the original definition taxes logic.

Two years later, Blakeslee[3] had already extended his definitions, in an attempt to further the homology of his mating types and 'sex'. It is in an attempt to follow this extension of the original definitions that, in my opinion, Drayton and Groves have gone astray.

Indeed, without differentiated male and female sex organs, Blakeslee could scarcely have made a definition on the basis of morphology, as Drayton and Groves would have one to believe.

The separation of morphological sex organs on separate plants (dicœcism) is indeed, as stated by Drayton and Groves, "a phenomenon of fundamental biological importance". This is one means of ensuring cross-fertilization, as opposed to selfing. It is by no means the sole method of ensuring this result which Nature has evolved. Sterility factors, in particular, seem to have arisen in all groups in which the problem has been investigated. The various mechanisms are, in total, of even greater "fundamental biological importance".

As the terms homo- and heterothallism are used in the current mycological literature, they embrace that total concept. A homothallic fungus is one in which the sexual cycle can be completed starting from a single haploid nucleus; a heterothallic fungus is one in which the sexual cycle can only be completed by the union of two, physiologically different, haploid nuclei. Referring to Blakeslee's original paper[2], in the two paragraphs immediately following his definition are statements concerning whether zygospores can or cannot be obtained from a "single spore". The present concept differs from Blakeslee's only in that it substitutes the more precise term "haploid nucleus" for "single spore".

Unfortunately, homo- and heterothallic have been somewhat pre-empted by botanists for use as morphological terms. *Marchantia polymorpha*, for example, is often referred to as heterothallic rather than dicœcious. Purists have objected to using monœcism and dicœcism for both gametophyte and sporophyte generations, and Blakeslee's terms have been welcomed for such groups as the mosses and liverworts, where they are used in a morphological sense. Mycologists, however, have generally held to the physiological definition originally propounded by Blakeslee.

What would be the results if one were to follow Drayton and Groves, and certain botanists, and were to interpret homo- and heterothallism as morphological terms? With very few exceptions, the fungi would be universally homothallic; for example, all Basidiomycetes, including the rusts and smuts, nearly all Ascomycetes, including all the usual genetic tools, etc. The fundamentally significant biological (genetical) principle—the development of outbreeding mechanisms—would be obscured and would occur in two groups: a very few 'true' heterothallic (= dicœcious) forms, and self-sterile homothallic forms. The vast and growing literature of microbial genetics would be filled with a misuse of the terms; and Blakeslee's classical mucors would have to be taught as homothallic (self-sterile) rather than as heterothallic.

What are the results if one adheres to established usage (and, I believe, to Blakeslee's original definitions) and interprets the terms as physiological ones? For the exceedingly few cases in the fungi in which male and female sex organs are differentiated and borne on separate thalli, a modifying word will have to be added: these fungi are dicœcious as well as heterothallic. Examples are *Stromatinia narcissi*, special strains of '*Hypomyces*' *solani* f. *cucurbitæ*, certain Laboulbeniales, and some water moulds. Nearly all the remaining heterothallic forms are monœcious. Whitehouse's[4] corresponding "morphological heterothallism" and "physiological heterothallism" are unnecessary in that all heterothallism is essentially physiological, and the morphological concept is better expressed with a morphological term, here dicœcious or monœcious.

The purist objecting to monœcious and dicœcious in gametophytes may prefer the alternative transliteration, monoicous and dioicous, now taking hold in the bryophyte literature, or could use Whitehouse's[4] haplo-monœcious and haplo-dicœcious. Blakeslee's[3] terms homo- and heterophytic, offered as equivalents in the sporophyte of the terms monœcious and dicœcious, have not come into general use but are available if needed. In my opinion, the terms homo- and heterothallic should be left for the mycologists' use in discussing the type of physiological phenomenon which Blakeslee observed.

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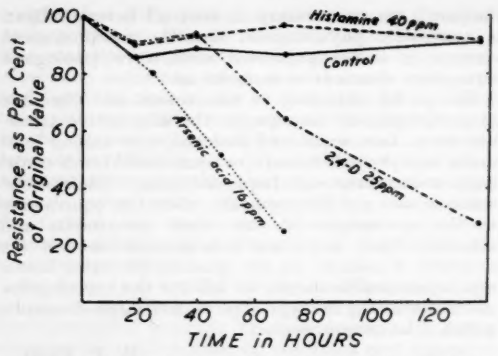
Phytotoxicity of Histamine, Arsenic Acid, and Dichlorophenoxyacetic Acid, and Methods of Testing

The recent paper by Allen and Skoog[1] on the phytotoxicity of imidazoline derivatives prompts this report on tests which have been made with the related β-imidazolyl-4-ethylamine (histamine). Some comments are added concerning the suitability of methods for measuring toxicity.

Tests were made with histamine because it is liberated in wounded animal tissues, is highly toxic to them, has been recorded as occurring in plant tissues[2], and because a phytotoxic substance is liberated when some plant tissues are macerated[3]. Tests were also made with 2,4-dichlorophenoxyacetic acid and arsenic acid to give a basis for comparison.

Tests with the method described below confirmed that the undiluted sap extracted from potato tubers was highly toxic to disks of such tubers. A chemical test also confirmed the presence of a substance reacting like histamine in the extracted sap, obtained from tubers macerated in a Waring blender. For this test, the conditions of diazotization recommended by Havinga *et al.*[4] were used. The procedure for preparing the sample to be diazotized was based on the methods devised by Koessler and Hanke[5], namely, add 2 vol. ethanol, adjust to *p*H 4, filter, chill overnight, filter, evaporate to original volume under reduced pressure, filter, add sodium hydroxide to 20 per cent concentration, filter, extract with amyl alcohol, extract with hydrochloric acid, evaporate to dryness on a water bath, dissolve in water and filter, add sodium hydroxide as before and repeat process to final filtration, then diazotize. The colour obtained indicated the equivalent of approximately 1 μgm. of histamine dihydrochloride per ml. of original sap macerate.

For testing toxicity, disks of potato tuber 19 mm. diam. × 1 mm. thick were used. After being cut, they were washed for five hours in an aerated isosmotic solution of sea salt (approx. $N/10$) and then transferred to 300 ml. of fresh salt solution to which the histamine or other substance had been added.



Graph showing effects of certain substances on the electrical resistance of slices of potato tuber (16 p.p.m. H_3AsO_4, 25 p.p.m. dichlorophenoxyacetic acid and 20 p.p.m. histamine (dihydrochloride) are equimolar)

The solutions were constantly aerated and kept at 24° C., and toxicity was determined by the fall in resistance of the disk, determined between two electrodes at 1,000 c./s. [4] (the more potent the poison the more rapid is the fall in resistance). The disks were handled with forceps and rubber gloves.

As 1 p.p.m. and 5 p.p.m. of histamine dihydrochloride and 10 p.p.m. of dichlorophenoxyacetic acid had little if any effect on potato disks over a period of a few days, tests were made at higher concentration. The accompanying graph shows some results obtained, each point in the figure representing the mean value for two disks. For clarity the results with 20 p.p.m. of histamine dihydrochloride have been omitted, as they are similar to those obtained with 40 p.p.m., even to the rise at the 70-hr. measurement. It will be seen that at 20 and 40 p.p.m. histamine dihydrochloride has negligible if any toxic action. Accordingly, it is unlikely that histamine or histamine alone is the phytotoxic principle in expressed potato sap. In its negligible response to histamine, the central tissue of potato tubers differs from some animal tissues. In its negligible phytotoxicity histamine appears to resemble some of the imidazoline compounds with small substituted side-groups[1]; however, it must be remembered that these imidazoline compounds were tested by other methods.

The above method is a method for testing local toxicity, and shows that arsenic acid has greater local toxicity to potato tubers than dichlorophenoxyacetic acid. Arsenic acid also has greater remote toxicity than dichlorophenoxyacetic acid to mature roots of skeleton weed[7]. However, tests on young bean plants (growth-regulating tests) do not give similar results for remote toxicity, as shown by the following experiment made according to the general technique of Lucas and Hamner[8].

0·023 ml. of 0·1 per cent dichlorophenoxyacetic acid at *p*H 3·0, applied to one primary leaf per bean plant, reduced bud weight by more than 50 per cent (in eight days). On the other hand, 0·023 ml. of 1·0 per cent arsenic acid similarly applied had no effect whatever on bud weight, although one-third of each of the treated leaves was killed. The failure of this experiment to demonstrate the remote toxicity of arsenic acid is not necessarily attributable to the rapid death of tissues in the neighbourhood of the area of application. With skeleton weed it has often been possible to kill the roots to a depth of 18 in. or more by the application of 5–7½ per cent arsenic acid to the leaves, even though the leaves were discoloured and dead within 18 hours.

Certain tests for toxicity were recently reviewed by Blackman[9], who pointed out that techniques utilizing depression in growth or percentage mortality after spray application have the advantage that they are equally suitable for estimating the toxicity of compounds which do not come within the category of growth regulators. Nevertheless, the above electrical method should be considered eminently suitable for determining the local toxicity of poisons to mature tissues which are capable of little growth, which may be obtained in the form of thin slices, and in which death is not readily determined by visual observation. With micro-electrodes it is possible to work on smaller slices. Moreover, the method has the advantage that it may be used on root tissues as well as on stem tissues; this may be important, because root tissues do not necessarily respond to auxins and poisons in the same way as stem tissues. The saline solution can be buffered or otherwise modified.

Tests for remote toxicity to roots of perennials are at present difficult and laborious. Since remote toxicity depends on both effectiveness of translocation and on local toxicity, the above electrical method should be useful in screening tests of likely poisons for the roots of perennial plants. At present most screening tests are done on comparatively young tissues. However, it must be recognized that poisons will not necessarily behave similarly on young tissues and on mature tissues such as the roots of perennials.

Further work is being done on the identity of the toxic principle liberated on macerating plant tissues.

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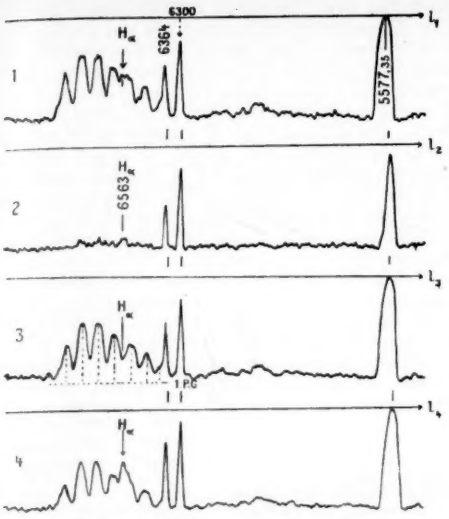
Great Intensity Variations of H_α and Effects in Auroral Spectrograms taken in Rapid Succession

By means of a new spectrograph, constructed by J. Cojan at the Société Générale d'Optique, Paris, combining the high light power $F : 0{\cdot}65$ with a fairly good dispersion, four spectrograms were taken at the Auroral Observatory, Tromsoe, on December 3, 1951, at about 23h. 00m. The spectrograms were taken on Kodak 103*a*-*T* plates and in rapid succession on the same plate with times of exposures from 4 to 10 min.

Photometer curves of the four spectrograms in the long-wave region from the green line towards the red part are shown herewith, in which the horizontal lines l_1, l_2, l_3, l_4 indicate the zero position of the registering galvanometer corresponding to an opaque plate. We notice that, in spite of the short exposures,



the green line is greatly over-exposed, except in spectrogram (2). In addition to the green line, we notice the red O I doublet (6300, 6364), the H_α-line, and bands belonging to the first positive group of nitrogen (indicated by I.P.G. on curve 3).

The great variations in the intensity distribution of these lines and bands must be co-ordinated with the way in which the exposures were made.

Spectrogram 1. Exposure 4 min. towards a band with ray structure appearing near the horizon towards the south and south-east.

Spectrogram 2. Exposure 5 min. towards auroral ray structures near the zenith.

Spectrogram 3. Exposure 7 min. on a homogeneous arc of moderate intensity towards the north.

Spectrogram 4. Exposure 10 min. towards auroral rays, where they appeared with the greatest intensity.

As spectrogram (2) mainly corresponds to auroral rays of great altitudes, and (3) to the low altitude of about 100 km. of an ordinary arc, they give a brilliant illustration of the two following well-known altitude effects: (*a*) enhancement of the red O I doublet with increasing altitude; (*b*) enhancement of the red bands of the first positive group of nitrogen towards smaller altitudes; this effect explains the red lower border sometimes observed on auroral arcs (red aurora of type *B*).

While H_α appears with considerable intensity on spectrograms (1) and (4), it is just noticeable on (2) and absent on (3). This great variability of the intensity of H_α can be explained in a simple way on the views I have proposed (for example, refs. 1, 3, 4, 8), that the auroras and magnetic disturbances are produced by solar electric ray-bundles composed of rays of electrons electrostatically neutralized by positive ions, preferably protons.

The correctness of this view was shown during 1939–40, when it was seen[6–10] that hydrogen lines occasionally appeared in the auroral luminescence and showed a Doppler effect corresponding to velocities of the protons towards the earth of the order of 1,000 km./sec. The Doppler effect of auroral *H*-lines has also recently been studied by Gartlein[11] and by Meinel[12].

As shown in previous papers[4,7,8], a bundle composed of protons and electrons has the following properties: the electric current density i is equal to $ne(V_e - V_p)$, where V_e and V_p are the velocities of the electrons and protons respectively, n is number of electrons and protons per unit volume. The number of protons entering the atmosphere in unit time relative to that of the electrons is equal to V_p/V_e, and the great variability of the intensity of the *H*-lines in the auroral luminescence is thus first of all due to a change of the relative proton velocity.

With increase of proton velocity, however, the magnetic stiffness of the bundle increases and consequently the distance of the aurora from the magnetic axis increases. This may explain why H_α appears strong on spectrogram (1), which corresponds to an aurora with ray-structure low down on the southern sky.

For the *H*-lines to be emitted the protons must be neutralized. At great altitudes the neutralized fraction is very small, but increases downwards. Further, if the energy of the protons is not greater than that of the electrons, the protons will be stopped at a considerably higher level than the electrons. In this way we explain the small intensity of H_α on spectrogram (2), which may correspond to an altitude so great that only a small fraction of protons is neutralized.

The absence of H_α from spectrogram (3) may result from two causes. The appearance of the arc on the northern sky indicates a small relative proton flux in the solar bundle. Small proton flux means small relative velocity and penetrating power of the protons. Consequently, they may be stopped before reaching to the lower part of the arc, from which the light through the slit has been emitted.

Spectrogram (4), showing a strong H_α-line, may correspond to altitudes where a considerable fraction of the protons is neutralized and not absorbed.

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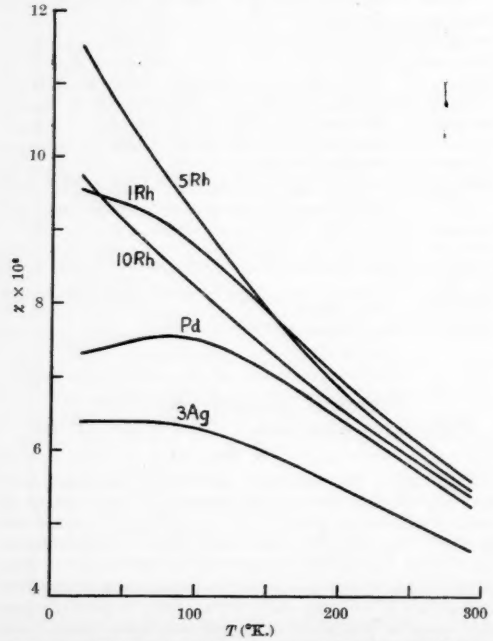
Magnetic Susceptibilities of Palladium–Rhodium Alloys from 20° to 300° K.

The rapid, yet accurate, method of measurement and the results thereby obtained for the magnetic susceptibilities of platinum, rhodium and palladium between liquid hydrogen and room temperatures have been previously described by two of us[1]. The same measurement techniques were afterwards applied to a series of polycrystalline palladium–silver alloys; the specific heats of these alloys have also been investigated (both sets of results yet unpublished). The results, when interpreted through the collective electron theory, make possible an estimate of the size

and shape of the normally unfilled portion of the *d* electronic energy-band of metallic palladium, on the assumption that the addition of small amounts of silver to palladium causes a reduction of the number of holes in the *d*-band without significantly modifying its shape. With the filling of the band, it would be expected that the magnetic susceptibility and its variation with temperature would be affected. It was actually found experimentally that both decreased monotonically with increased silver content.

It therefore became of interest to explore the possibilities of increasing the number of holes in the *d*-band by alloying small amounts of an appropriate metal with palladium, and to study the resultant effects on the magnetic susceptibility. Rhodium (atomic number 45), with one less electron per atom than palladium (atomic number 46), in contrast to silver (atomic number 47) with one more, appeared to be an obvious element to choose for this purpose. Moreover, the similarity in the size of the atoms of palladium and rhodium would favour extended solid metallic solubility; hence, although a phase diagram for palladium–rhodium alloys is not available at present, we can be fairly confident that at least over a small range of palladium-rich compositions there are no complicating phase changes.

We have now investigated the paramagnetic susceptibilities of a number of spectrographically pure palladium–rhodium polycrystalline specimens from room temperature down to that of liquid hydrogen, by the experimental method referred to above. The results for the three specimens (1, 5 and 10 per cent rhodium) that have been studied to date are presented in the accompanying graph along with those previously obtained for pure palladium and a 3 per cent silver palladium–silver alloy. Each curve represents approximately ninety experimental points evenly distributed over the entire temperature-range. The mean deviation of the points from the corresponding curve is about 0·2 per cent of the susceptibility. The substantial increase of the low-temperature susceptibilities, which accompanied the additions of rhodium up to the 5 per cent rhodium alloy, gives some support to the general type of interpretation suggested for the palladium–silver alloys. It is not surprising, however, to find that, for a further increase in rhodium content, the magnetic susceptibility began to decrease, the paramagnetic susceptibility of pure rhodium being only about 10^{-6} over the entire temperature-range in question. Undoubtedly, the dependence of the experimental susceptibility versus temperature curves on the composition of these alloys will provide valuable material for the elucidation of the electronic structure. At present, however, we merely present our initial experimental results. We are continuing our study of this and other related alloy series and will report more fully later.



Gram-susceptibility versus absolute temperature of pure palladium (Pd) of palladium–rhodium alloys of 1, 5 and 10 atomic per cent rhodium (1 Rh, 5 Rh, 10 Rh), and of a palladium–silver alloy of 3 atomic per cent silver (3 Ag)

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Acid Salts of Monobasic Organic Acids: a New Series of Primary Standards for Alkalimetry

It has long been known[1–3] that most monobasic acids *HX* are capable, in suitable circumstances, of combining with their metallic salts *MX* to form 'acid salts'; for example, of the type $(MX)_m(HX)_n$.

The potassium compounds of this type derived from organic acids frequently have the stoichiometric composition of 1 mole acid : 1 mole salt, and are easily obtained and purified. Certain of these substances would probably prove highly suitable as primary standards in volumetric analysis; their use in the preparation of buffer solutions has already been noted[2,3]. In particular, the use of a new compound, potassium hydrogen *bis*-3 : 5-dinitrobenzoate (no definite melting-point, but explodes on strong heating), is proposed (found : K = 8·56, 8·58 per cent; equivalent weight = 461·7, 463·0; calculated for $C_{14}H_7O_{12}N_4K$, K = 8·46 per cent; equivalent weight = 462·3).

This substance is easily obtained by dissolving 21·2 gm. of 3 : 5-dinitrobenzoic acid (B.D.H.) (2 equiv.) in 60 ml. of acetone and adding a solution of 3·5 gm. A/R potassium carbonate (1 equiv.) in 20 ml. hot water. On cooling, small needles separate, and may be recrystallized from a 3 : 1 acetone–water mixture without alteration. After drying in a vacuum desiccator, the substance is non-hygroscopic, stable in air, and a sample has been kept for more than six years without a detectable change. As the dissociation constant of 3 : 5-dinitrobenzoic acid is $1{\cdot}57 \times 10^{-3}$ at 25° [4], a suitable indicator for its titration with 0·1 *N* sodium hydroxide is thymol blue (alkaline range). The solubility of 3 : 5-dinitrobenzoic acid in water is rather low (0·00635 mole per litre at 25° [5]) and the potassium hydrogen salt is only slightly more soluble than this, being decomposed by water into the free acid and a solution of the potassium salt together with a little of the acid.

No organic compounds of this type have been proposed previously as alkalimetric standards. Potassium bi-iodate, already in use for alkalimetry and iodimetry[6], is a similar acid salt of an inorganic monobasic acid. Alkali metal hydrogen salts of organic dibasic acids already used as standards suffer from several disadvantages not possessed by the substance now advocated. For example, potassium hydrogen phthalate must be recrystallized from water above 35° [7]; potassium tetroxalate must be kept under conditions of definite vapour pressure[8]; potassium hydrogen oxalate cannot be recrystallized from water without change[9]; potassium hydrogen tartrate has a low solubility in water and is difficult to obtain pure[10].

This investigation is being continued, and will be discussed in greater detail elsewhere.

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Thermal Transformations of the Aluminas and their Hydrates

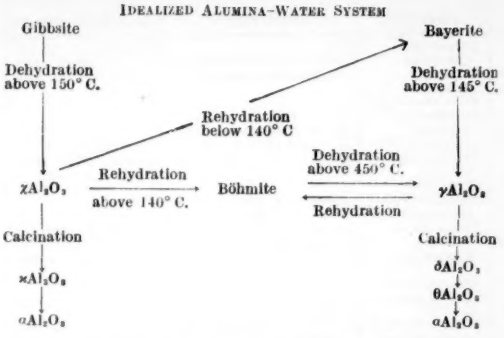
SEVERAL polymorphic forms of anhydrous alumina derived from the calcination of hydrated aluminas have been described by various authors[1–3]. The interpretations made of the relationships which exist between the hydrated and anhydrous forms presuppose that the dehydration of gibbsite and bayerite occur through böhmite, and that the dehydration of the böhmite derived from gibbsite can unaccountably yield one of two series of transformations before α-alumina is finally produced.

Work which we have carried out over a number of years and which will be published elsewhere has led us to believe that the böhmite which is encountered in the dehydration of both gibbsite and bayerite is produced by secondary reactions between the original dehydration products, which are virtually anhydrous aluminas, and the water which is released during the reaction, and our conclusions are illustrated in the accompanying diagram.

Bayerite gives rise on calcination to γ-alumina which is capable only of hydration to böhmite. Böhmite also yields only γ-alumina, so both these hydrates give rise to the γ—δ—θ [2] forms of anhydrous alumina.

Gibbsite, on the other hand, yields initially another form of alumina. This anhydrous alumina has a crystal form for which the lattice spacings of the two most intense lines have *d* values 2·11 and 1·39, the latter being identical with that of one of the major lines of γ-alumina. It is convenient to label this χ-alumina, and we have found that this is, in fact, only one of the components of the (γ + χ)

IDEALIZED ALUMINA–WATER SYSTEM



mixture derived from gibbsite which had previously been designated χ [3]. True χ-alumina is capable of hydration to bayerite at temperatures below 140°, and above 140° to böhmite, and on further calcination yields true κ-alumina before final conversion to α. In practice, therefore, we find on dehydrating gibbsite a mixture of χ-alumina and böhmite, the latter being derived from the secondary reaction of χ with water. Subsequent calcination at higher temperatures therefore gives rise to mixtures of the two series of anhydrous forms, that is, γ—δ—θ—α, associated with the böhmite component, and χ—κ—α associated with the original dehydration product χ.

We are indebted to Mr. H. P. Rooksby of the Research Laboratories of the General Electric Company for his interest and helpful discussion.

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Chromatography of Rubber Accelerators and Anti-Oxidants on Silica Gel

THE chromatographic separation on alumina columns of certain constituents from the acetone extracts of vulcanized rubbers has been reported by Bellamy and co-workers[1] and by Mann[2]. As an adsorbent for such materials, alumina suffers from certain disadvantages, in particular, its tendency to favour chemical change in labile adsorbates. The successful use of silica gel/'Celite' for the chromatographic separation of a variety of ingredients from propellants and high explosives[3,4] suggested that this adsorbent might prove equally useful for the separation of the ingredients of vulcanized rubbers, and this has, in fact, been borne out by recent work in this laboratory. The procedure adopted for the qualitative examination of a rubber extract is as follows. A number of separate portions of the extract (each equivalent to 0·2–0·4 gm. of the rubber) are chromatographed on 1-cm. diameter columns using a series of different binary solvent mixtures as developers. When the extruded columns have been streaked with appropriate reagents, the positions of the zones, together with the colours of the streaks, give a reason-

Compound	Streak reagent	Developing solvents
Diphenylguanidine Triphenylguanidine Thiocarbanilide	30 per cent w/v Sodium hypochlorite solution	25 ml. of 20 per cent ethyl alcohol in light petroleum
Tetramethylthiuram monosulphide Tetramethylthiuram disulphide	5 per cent w/v Aqueous $CuSO_4.5H_2O$	25 ml. of 1·5 per cent ethyl acetate in benzene
Mercaptobenzthiazole (MBT)	5 per cent w/v $Bi(NO_3)_3$ in 0·5 *N* nitric acid	
Tetra ethylthiuram disulphide	5 per cent w/v Aqueous $CuSO_4.5H_2O$	25 ml. of 2 per cent ethyl acetate in carbon tetrachloride
Dibenzthiazolyl 2-disulphide (MBTS) 2-Benzthiazolyl N′-cyclohexyl sulphenamide	5 per cent w/v $SnCl_2.2H_2O$ in 2·5 *N* hydrochloric acid followed by 5 *N* sodium acetate followed by 5 per cent w/v $Bi(NO_3)_3$ in 0·5 *N* nitric acid	25 ml. of benzene
Phenyl β-naphthylamine Phenyl α-naphthylamine	1 per cent w/v $(NH_4)VO_3$ in 60 per cent sulphuric acid	25 ml. of 1 per cent ethyl ether in light petroleum

ably unambiguous identification, which can be further confirmed by ultra-violet absorption measurements.

Using this method, it is possible to distinguish between the compounds named in the table even when present in admixture with one another and with other normal compounding ingredients, including pine tar. In most cases quantities as small as 0·05 mgm. can be detected on a column of 1 cm. diameter.

The same developers can be used for the detection of other accelerators and anti-oxidants, although complete separation from all other compounds cannot always be attained with a single chromatographic treatment. Thus it has been possible to detect *m*-toluylene diamine, *sym*-diphenyl-*p*-phenylene diamine, *sym*-dinaphthyl-*p*-phenylene diamine and some complex commercial materials containing, for example, aldehyde-amine condensation products or polymerized dihydroquinoline derivatives. The separation of more closely related compounds can also be attained. For example, derivatives of dimethyl-, diethyl- and dibutyl-dithiocarbamates can readily be distinguished from one another by chromatographing the brown copper complexes.

With minor modification, some of the methods can be adapted for quantitative determination. Good recovery of adsorbates has been obtained with the particular silica gel adsorbent in use. In this connexion, Bloomfield[5] has suggested that alumina may cause decomposition of labile accelerators during chromatography, and that such products may be mistaken for transformation products of the accelerator produced during the vulcanization process. Mann[2] has, in fact, observed the decomposition of dibenzthiazolyl 2-disulphide to mercaptobenzthiazole on alumina columns. In contrast, I have found that dibenzthiazolyl 2-disulphide can be chromatographed unchanged on our silica gel columns. Nevertheless, I have identified both mercaptobenzthiazole and dibenzthiazolyl 2-disulphide in the extracts of rubbers accelerated with either; this is in agreement with the findings of Dufraisse and Houpillart[6]. I have also observed mercaptobenzthiazole in the extract of a rubber accelerated with 2-benzthiazolyl N′-cyclohexyl sulphenamide. However, considerable care is required in the interpretation of the chromatograms, as there is evidence that labile accelerators can undergo further transformation during the process of acetone extraction of the rubber.

This investigation is continuing and will be reported in detail elsewhere.

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Translocation of Iron in Podzol Formation

Several mechanisms have been postulated to account for the translocation of iron and aluminium in the process of podzol formation. Thus Jones and Willcox[1] suggest that simple organic acids such as oxalic acid are responsible for the solution of the sesquioxides, while numerous workers[2] consider that the free oxides are peptized by the action of humus and move as sols.

It has been found in this laboratory that water extracts of the undecomposed leaves and bark of the New Zealand kauri (*Agathis australis*) and of Scots pine needles (*Pinus sylvestris*) are capable of causing rapid reduction of soluble ferric compounds to the extent of some 4–5 mgm. of iron per gram of air-dry Scots pine needles. Furthermore, over a wide range of *p*H values (4–7), the extracts are capable of causing non-biological solution of relatively large amounts of hydrous ferric and aluminium oxides. Ferrous iron, as determined by αα′-dipyridyl, accounts only for a part of the dissolved iron; but as the extracts are still capable of reducing considerably more iron than has already been dissolved, it is unlikely that the difference between the total and the dipyridyl-reactive iron represents iron in the ferric state. Experiments on the effect of the plant extracts on the recovery of ferrous iron by dipyridyl from solutions of ferrous sulphate show that complexing of the ferrous iron is, in part at least, the cause of the discrepancy between the total and the dipyridyl-reactive iron. It therefore seems probable that the whole of the dissolved ferric oxide is reduced to the ferrous state. Continuous aeration of the reaction mixture appears to have little or no effect on the solution and reduction of ferric oxide. These results resemble very closely those previously obtained with anaerobically fermented grass[3].

It can be seen from these results that the percolation of rainwater through undecomposed coniferous litter provides all the necessary conditions for the leaching of sesquioxides from the surface layers of the soil. In view of the capacity of the aqueous extracts for reducing ferric iron, it seems most probable that translocation of the iron takes place in the form of a ferrous organic complex.

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Relief of Hypoglycæmic Convulsions with Butyric Acid

THE lower volatile acids, acetic, propionic and butyric, have been widely studied in relation to intermediary metabolism[1,2]. Propionic acid is known to be glucogenic, and sodium propionate has been found to relieve severe hypoglycæmic symptoms in an adrenalectomized ewe; but sodium acetate was without effect[3]. Butyric acid has usually been studied in relation to the metabolism of fat and the production of ketone bodies[4]; but there are some suggestions that it may also be implicated in carbohydrate metabolism[5]. Moreover, Jarrett, Potter and Filsell[6] have found that the concentration of blood sugar and of pyruvic acid was increased after sodium butyrate had been injected into the blood-stream of sheep.

In view of the possible association of the metabolism of butyric acid with that of carbohydrate, the effect of sodium butyrate administration on an animal in convulsions was studied.

Eight young merino lambs aged between 1 and 28 days were fasted for 24 hr. and then given an intravenous injection of insulin in the manner employed by Comline *et al.*[7]. The subsequent hypoglycæmic convulsions were found to be relieved by an intrajugular injection of 10 ml. sodium butyrate, containing 2·5 m*M* butyric acid/kgm. neutralized to *p*H 7·0 with sodium hydroxide. Sodium propionate (2·5 m*M* propionic acid/kgm.) had a similar effect, but there was no response to sodium acetate (2·5 m*M* acetic acid/kgm.).

Convulsions which supervened in two adult ewes in which the splanchnic nerves had been sectioned[8] were similarly relieved by 30 ml. of either butyrate or propionate but not by acetate.

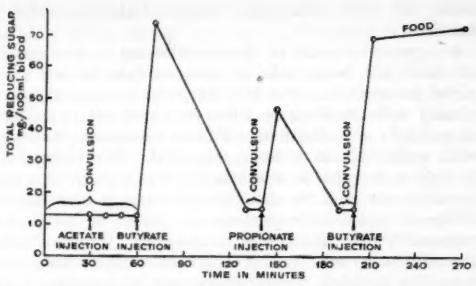
Insulin-induced hypoglycæmic convulsions in rabbits were also relieved by 5 ml. of intravenous sodium butyrate (2·5 m*M* butyric acid/kgm.) and by propionate but not by acetate.

Total reducing sugar in the blood[9] estimated in samples taken prior to the insulin injection, during convulsion, and ten minutes after the injection of the volatile acids, showed that the relief of the convulsions was accompanied by a considerable rise in blood sugar.

Convulsions in lambs ceased immediately after the injection of butyrate: the coma which supervened for 1–2 min. gradually subsided and within 5–10 min. the animals had regained their feet. An apparently normal state was maintained for about 30–40 min.: the animals then became lethargic and after 50–60 min. again convulsed. This second convulsion could be relieved with butyrate and if, on recovery, the animals were allowed to suck from their dams no further convulsions ensued.

Butyrate, when administered to the adult ewes, however, relieved hypoglycæmic convulsions but with less spectacular effect. Acetate was found to be ineffective and propionate gave no more relief than butyrate.

Rabbits were observed to respond to butyrate injection in much the same manner as lambs and ewes. On some occasions the coma that followed the injection persisted for as long as 20 min., after which the animals recovered rapidly and began to eat if allowed access to food. If prevented from feeding, they became convulsed again 60–90 min. later, and under these conditions were relieved by another injection of butyrate. Acetate was again ineffective and propionate did not relieve the symptoms as effectively in the rabbits as in the lambs and sheep.



Blood sugar curves of lamb *F* (aged 28 days) after sodium acetate, propionate or butyrate (2·5 m*M*/kgm.)

The concentration of sugar in the bloods of the lambs was raised from the low level of 10–15 mgm./100 ml. to which it fell during the convulsions, to 50–80 mgm./100 ml. ten minutes after the injection of butyrate. Injection of propionate led to a rise of only 30–40 mgm./100 ml., while acetate produced no alteration in the blood-sugar level (see graph).

Similar results were obtained with adult sheep and rabbits: the butyrate in all cases led to a greater increase in blood sugar than the propionate. The sugar in the blood of rabbits, however, was not increased as much as that of the lambs and sheep, but it remained elevated for a longer period.

Sodium propionate is known to be glucogenic and therefore might be expected to relieve hypoglycæmic convulsions: the greater efficiency with which sodium butyrate can also relieve them suggests that butyric acid may readily be converted to glucose *in vivo*. The mechanism of this conversion is obscure.

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'Lipochondria' and the Golgi Substance in Epithelial Cells of the Epididymis

BOTH J. R. Baker[1] and O. L. Thomas[2] have expressed the view that 'lipochondria' (discrete sudanophilic droplets supravitally stainable with methylene blue and neutral red) are transformed into the classical Golgi network during the processes of fixation and impregnation with silver and osmic acid techniques. Thomas[3] also considers that mitochondria are involved in the develop-

ment of the classical Golgi network during fixation.

In epithelial cells of the duodenum of the mouse we have not been able to demonstrate to our complete satisfaction that the droplets stainable supravitally with methylene blue and neutral red ('lipochondria'[1]) are identical with the substance stainable with sudan black in fixed material. The Golgi zone in this cell type is surrounded by numerous mitochondria as well as droplets of various size having different optical properties, so that for us it was impossible to determine accurately which bodies actually were within the Golgi zone and which were not. We decided, therefore, to turn to a study of the epithelial cells of the head of the epididymis of the mouse. These cells are relatively large compared with the epithelial cells of the duodenum and possess a large, clearly defined Golgi zone. Mitochondria and droplets are few in number in the immediate vicinity of the Golgi zone, and do not interfere noticeably with observations on this region of the cell.

We found that in this particular cell a classical Golgi network with filaments, lamellæ and vacuoles was strikingly demonstrable with phase contrast and less clearly but nevertheless definitely demonstrable with the ordinary light microscope in fresh unstained material. (A typical Golgi network may also be seen with phase contrast in some of the cells in fresh preparations of the seminal vesicles and ventral prostate gland of the mouse.) We also found that none of the substance of the Golgi zone stains supravitally with either methylene blue or neutral red. Droplets in the region between the nucleus and the Golgi zone took up these dyes avidly, but even after long intervals, when the nucleus became stained, there was still no evidence of staining within the Golgi zone. In fact, this zone was the one area of the cell which remained completely refractory to staining with these dyes. The strands of the network which appeared dark with the phase contrast and light microscopes stained diffusely with sudan black in fixed material. With the Kolatchev–Nassonov method these strands were impregnated with reduced osmic acid. Comparison of electron micrographs of positive and negative images of the Golgi material indicated that the substance responsible for the reduction of osmic acid (the osmiophilic component) is situated in the cytoplasm adjacent to the vacuoles and canals of the osmiophobic component. This suggests that the osmiophobic component represents the negative image of the Golgi substance frequently seen in routinely prepared and stained specimens, and that the osmiophilic component, being intimately associated with protein materials in the cytoplasm, does not contribute materially to this negative image.

Thus it may be stated that in this cell type the Golgi substance is clearly visible in the living cell as a definite network, classical in its form, which so far as we were able to determine is not modified by fixation with suitable fixatives. Further, it may be stated that in this instance the 'lipochrondria' of Baker have no structural or obvious chemical relationship to the Golgi substance, since by definition the 'lipochondria' are stainable supravitally with methylene blue and neutral red while the Golgi substance is not.

These results are comparable to those of O'Leary[4] who, following the lead of Bensley[5], demonstrated the negative image of the Golgi substance in living

× 3,200

cells of the islets of Langerhans of the mouse and determined that in this case also the Golgi substance was not stainable supravitally with either methylene blue or neutral red.

We would like to add that we are in agreement with Baker[1] and Thomas[2] to the extent that, whenever feasible, living tissues should be studied experimentally in preference to fixed tissues, and that, whenever possible, studies on fixed tissues should be supplemented by studies on living cells. We feel justified in pointing out at this juncture, however, that there are uncertainties inherent in conclusions drawn from comparisons made between living and fixed cells when the size of the structures under investigation in these cells are at the border line of, or beyond, the resolving power of the optical equipment used to make the comparison. We cannot agree with either Baker or Thomas that studies with the electron microscope have no place in the elucidation of the enigma of the Golgi substance. Rather, we believe with Beams *et al.*[6] that every available means of analysis should be used. The results reported above and those reported previously[7] are to us adequate demonstrations of the usefulness of the electron microscope in this area of investigation.

The results of this study will be reported in detail elsewhere.

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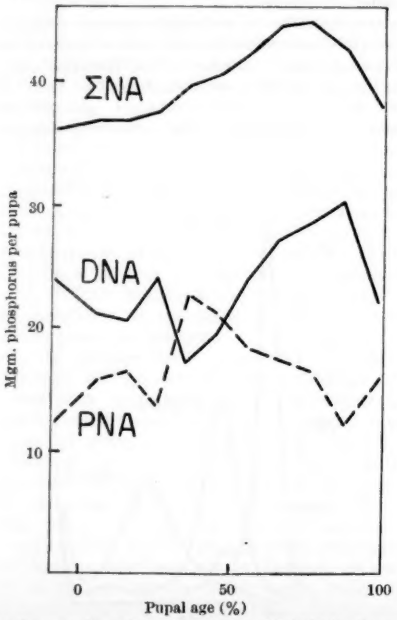
Nucleic Acid Metabolism during Insect Metamorphosis

THE transformation of the two nucleic acids, deoxyribonucleic acid and ribonucleic acid, one into the other has been postulated by Brachet[1], using developing sea urchin embryos as material for the investigation. Ribonucleic acid should be the precursor of deoxyribonucleic acid. These results have been questioned by Villee *et al.*[2] and Abrams[3], among others, who show that the amount of total nucleic acid phosphorus is not constant during development. Further, with the aid of phosphorus-32 and carbon-14 respectively, these investigators have demonstrated that the specific activity of deoxyribonucleic acid is much higher, up to fifteen times, than of ribonucleic acid. These results indicate that most of the deoxyribonucleic acid should arise from an endogenous precursor, which is not ribonucleic acid.

The insect pupa is a closed system in respect of nucleic acid metabolism. Moreover, metamorphosis is characterized by a profound histolysis of the larval tissues and a corresponding histogenesis of the imaginal organs. If there were any mutual interdependence of the two nucleic acids, this would be seen in such an organism. Therefore, investigations were carried out on the fly *Calliphora erythrocephala* (Meig.). As analytical method the phosphate fractionation devised by Ogur and Rosen[4] was used. The phosphorus determinations were checked by spectrophotometric readings at 2500 A.

As is clear from the graph, there is an obvious inverse relationship between the amounts of deoxyribonucleic acid and ribonucleic acid. Naturally this does not prove transformation from one acid to the other. However, it strongly suggests a mutual interdependence of the two nucleic acids as regards their synthesis.



Change in amount of deoxyribonucleic acid (*DNA*), ribonucleic acid (*PNA*) and total nucleic acids (*ΣNA*) during the metamorphosis period of *Calliphora*

There is an increase in total content of nucleic acid of about 25 per cent up to the point when histogenesis is almost finished. The phosphorus used seems to arise from the alcohol-soluble fraction. The final decrease is principally due to an increased decomposition of deoxyribonucleic acid during lysis of nuclei in the abdominal larval fat-body. The increase in amount of deoxyribonucleic acid during histogenesis is not only concerned with the growth of muscles in the thorax (cf. Agrell[5]). In the abdomen also there is an identical increase in deoxyribonucleic acid content, in spite of the fact that histogenesis processes are only very limited and consequently no increase in Feulgen-positive substance can be seen in this part of the body. It seems possible that deoxyribonucleic acid is synthesized in the cytoplasm of the abdominal fat-body cells in a form not detectable by the Feulgen reaction. The large cell granules of complex build could be the site of this process. The existence of cytoplasmic deoxyribonucleic acid has recently been shown to be probable by Zeuthen[6].

The inverse relationship in the amount of ribonucleic acid and deoxyribonucleic acid always shows the same course. However, the ratio of the two is remarkably different in different cultures of *Calliphora*; it varied from about 1·0 down to 0·4 in four experimental series of pupæ, all of which gave rise to normal imaginal flies.

IVAR AGRELL

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March 5.

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Progesterone in Body Fluids

A METHOD has been developed for the assay of progesterone by which as little as 4 μgm. of the hormone can be detected. It is based on the technique of extraction and partition between organic solvents[1] and subsequent separation and semi-quantitative estimation by chromatographic partition on filter paper[2]. The method has been used for the detection and semi-quantitative determination of progesterone in biological material. The results are summarized as follows.

Blood withdrawn directly from the ovarian vein of ewes contained progesterone in concentrations ranging from 0·5 to 2 μgm. per ml. (see table). On the other hand, all attempts to detect progesterone in peripheral blood were consistently negative, both in pregnant and non-pregnant animals, in mare, cow, ewe and sow, although the quantities of blood used for analysis ranged from 10 to 160 ml.; the blood analysed came mostly from the jugular vein (mare, cow, ewe and sow), occasionally also from the middle uterine artery and vein (ewe). No progesterone could be detected in blood from the caudal vena cava of a female rabbit seven days after ovulation.

In cases where progesterone was detected in blood, the residue left after extraction of the hormone was analysed for 'bound' or conjugated progesterone[3].

PROGESTERONE IN BLOOD FROM THE OVARIAN VEIN OF EWES

Animals examined	Condition of ewe	Condition of ovary	Quantity of blood (ml.)	Progesterone found (gm.)	Approximate concentration (μgm./ml.)
1	98 days pregnant	1 Corpus luteum	31	60	2
1	3 months pregnant	2 Corpora lutea	15	8	0·5
1	3½ months pregnant	1 Corpus luteum (left ovary) 2 Graafian follicles (right ovary)	35 41	55 40	1·6 1
1	8 days post œstrum	2 Corpora lutea	22	12	0·5
1	28 days post partum	Quiescent	40	nil	less than 0·1
5					

'Bound' progesterone did not exceed 15 per cent of the total. Blood samples in which no free progesterone was found gave consistently negative results when analysed for 'bound' progesterone.

The effect of intramuscular injections of progesterone on the level of progesterone in blood was studied on rabbits. Blood withdrawn from the caudal vena cava of a doe 25 min. after an injection of 25 mgm. pure hormone (in oil) showed a content of 0·2 μgm. per ml. No progesterone could be detected in rabbit blood 3 hr. and 8 hr. after injection.

Fluid obtained from Graafian follicles of a sow nearly at ovulation contained 8 μgm. progesterone per ml.

Cow's follicular fluid near ovulation contained 3 μgm./ml.; no progesterone was found in developing follicles, nor, three and four days after heat, in follicles which had failed to ovulate.

Fluid obtained from ovarian cysts of nine sows contained 1–5 μgm. progesterone per ml.

Luteal tissue from an elephant ovary, which had been preserved in formalin for 23 months, contained 2 μgm. progesterone per gram.

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March 5.

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Cell Surface Constituents and Yeast Flocculation

THE cell wall of *Saccharomyces cerevisiæ* holds nitrogen-containing complex polysaccharides. By a gradual extraction method I have obtained compounds which were homogeneous at sedimentation analysis and electrophoresis.

An aqueous suspension of fresh brewer's yeast was agitated with a laboratory stirrer for two hours at room temperature. A high-molecular mannan was thereby extracted, apparently being detached from the cell surface by friction. Analyses of the purified substance showed 1 per cent nitrogen and 0·2 per cent phosphorus. The molecular weight was calculated from sedimentation and diffusion measurements to be 340,000. The compound was of anodic migration in the *p*H range 3–10. At complete extraction 0·3 per cent was obtained from dry yeast. The substance was called 'cebrosan'.

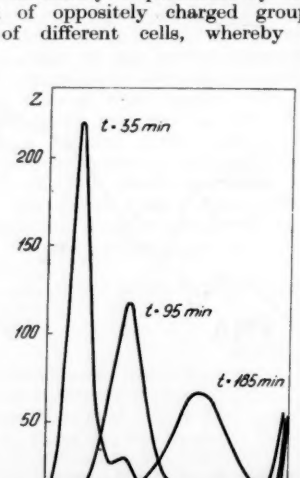
When the agitation was continued at a temperature of 30–45° C. a mucopolysaccharide with higher contents of nitrogen and phosphorus was extracted, of $s^0_{20} = 8{\cdot}1\ S$, and the isoelectric point 5·1. About 1 per cent from dry yeast was isolated. The substance was called 'mycetin'.

At subsequent high-speed agitation in a 'Turmix' blender about the same amount of yeast nucleic acids was extracted ($s^0_{20} = 2{\cdot}55\ S$). The preparations were often accompanied by two high-molecular carbohydrates ($s_{20} \sim 13$ and $16\ S$, respectively) in minor quantities. No cell proteins were extracted by this treatment.

When yeast of 25 per cent dryness was stored at 30–40° C. for two days, in the extracellular solution were found macromolecular carbohydrates in considerable amounts (6 per cent from dry yeast), at nitrogen contents of 5–7 per cent upon dry substance. Sedimentation analysis made evident four main compounds, of $s_{20} = 2{\cdot}8$, 4·0, 6·5 and $7{\cdot}2\ S$, respectively, as well as a carbohydrate of basic properties, of $s^0_{20} = 3{\cdot}6\ S$. The latter was isolated by precipitation with alcoholic ammonia. It gave Ehrlich's reaction for glucosamine, and contained 5 per cent nitrogen. It was of cathodic migration in the *p*H interval 4–11. A sedimentation diagram for the substance is given in the accompanying illustration.

From top fermentation brewing yeast were obtained the same compounds as from bottom fermentation yeast. An essential difference was the extraction of 1–2 per cent proteins on agitation of a top yeast suspension at 30–45° C., which was not observed with bottom yeast.

Electrophoretical investigations upon isolated cell-wall constituents made evident compounds of positive as well as negative charge. The flocculation mechanism is essentially explainable by the mutual attraction of oppositely charged groups on the surfaces of different cells, whereby large cell



Sedimentation diagram for the basic compound extracted from the cell wall

agglomerations are rapidly modified. A coating with proteins hinders the flocculation of top yeast, unless the *p*H of the medium is lower than their isoelectric point, and favours adherence to carbon dioxide bubbles during fermentation, by which the yeast rises.

The investigations were carried out at the Institute of Physical Chemistry, University of Uppsala, during 1948–51, with financial assistance from A. B. Stockholms Bryggerier, Stockholm. Detailed results will be published elsewhere.

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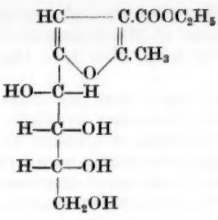
Biosynthesis of Vitamin C and a New Precursor

HEXOSE sugars and sugar acids have long been known to be concerned in the biosynthesis of vitamin C[1-3], and it was also reported by Nath *et al.*[4,5] that injection of acetoacetate causes an immediate rise of blood sugar in the rabbit and accelerates the biosynthesis of vitamin C in the animal system; although a higher dose of 180 mgm./kgm. causes about 50 per cent decrease in vitamin C in the blood of rabbits in half an hour, an increase to the extent of 500 per cent is observed in rats under identical conditions, thus indicating the enormous capacity of rats for the biosynthesis of vitamin C in their bodies, and showing at the same time the possibility of acetoacetate being concerned in the process too.

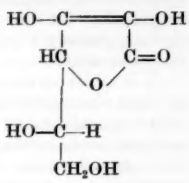
With the view of gaining some insight into the mechanism, glucose and acetoacetate (sodium salt), both separately and combined, were added to the medium used for germination of a legume—green gram (*Phaseolus mungo*). The seeds were first soaked in glass-distilled water for about three hours prior to keeping them in the presence of various aqueous media containing these different substances at *p*H 7·4. For each experiment, 500 seeds were taken and selected in such a way that each group had almost equal weight.

Because glucose has been found to condense with acetoacetate *in vitro*[6,7] to give rise to a product—2-tetra hydroxy butyl 5-methyl 4-carbethoxy furan (I), the structure of which resembles to a great extent that of ascorbic acid (II), and because both the constituents of (I) were found to be concerned in the biosynthesis of (II), it was also decided to study its effect in the process of biosynthesis of vitamin C. This condensation product (I) was prepared according to the method of West[6], with slight modification, as follows.

100 gm. of glucose finely powdered was mixed thoroughly with 100 gm. of fused zinc chloride; this mixture was then introduced in a round-bottomed 'Pyrex' flask, which was immersed in boiling water, and 50 gm. of ethyl acetoacetate and 50 c.c. of absolute alcohol were added. The mixture was then vigorously stirred continuously until a heavy yellow syrup was obtained, approximately in about 25 min. During this period of reaction, absolute alcohol (50 c.c.) was again added for the second time. The syrupy mass was then poured into about 150 c.c. of water and kept overnight in the refrigerator, when fine glistening needle-shaped crystals of the condensation product of glucose and acetoacetate were found to have separated out. The crystals were then separated



(I)

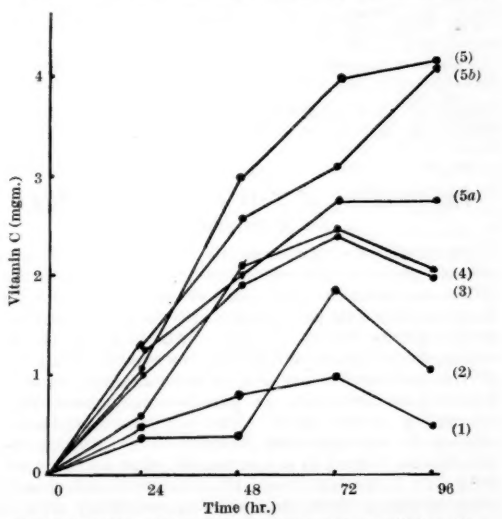


(II)

from the mother liquor and washed repeatedly with ice-cold water. The substance was freed from adhering glucose and other impurities by repeated crystallization from hot water. The yield was about 25 gm. The substance melts sharply at 153° C. (corrected) and $[\alpha]_D^{20}$, as found by West[6], is − 19·00° in water.

In order to prevent the ascorbic acid formed from being auto-oxidized during the process of germination, potassium *meta*-bisulphite, concentration 300 p.p.m., was added to all the different media, as recommended by Kendrick and Downer[8]. After the specified periods of germination in the dark, 100 seeds were removed from the dish, the testa removed and extracted repeatedly (thrice) with meta-phosphoric (3 per cent)–acetic acid (8 per cent) mixture, and vitamin C estimated according to the modified titrimetric method of Bessey[9].

All the experiments were repeated three times, and their average values, obtained with each type of substance in the germinating media after 24, 48, 72 and 96 hr., respectively, are shown graphically in the figure. The mean deviation in no case exceeded ± 0·18 up to 72 hr. This experiment was repeated several times, and the direct method of Roe and Kuether[10] (that is, by coupling the dehydroascorbic acid, formed by oxidation, with 2-4 dinitro phenyl hydrazine), which is much more specific for vitamin C, was used. Almost similar results were obtained by



Effect of various substances (in equimolecular quantity) on the amount of vitamin C formed during germination of 100 seeds (green gram): (1) acetoacetate (sodium salt) (72 mgm. per 100 seeds); (2) glucose (100 mgm.) and acetoacetate (72 mgm.) mixture per 100 seeds; (3) water; (4) glucose (100 mgm. per 100 seeds); (5) condensation product of glucose and acetoacetate (152 mgm. per 100 seeds); (5*a*) condensation product of glucose and acetoacetate (5 mgm. per 100 seeds); (5*b*) condensation product of glucose and acetoacetate (25 mgm. per 100 seeds)

this method also, thus confirming that the substance responsible for the decolorization of the indophenol dye in Bessey's method is nothing else but the ascorbic acid.

It is quite evident from the graph that, although glucose alone (100 mgm. per 100 seeds) has but slight effect in increasing the concentration of vitamin C, sodium acetoacetate alone (equimolecular quantity) decreases the same considerably, while a combination of the two in equimolecular proportion shows sudden acceleration after 48 hr.; and it is interesting to note that the freshly prepared crystalline condensation product (I) shows gradual increase in the quantity of vitamin C even from the very beginning, and the result after 96 hr. is more than 100 per cent higher than that with glucose alone, thus showing the possibility of its playing the part of a precursor of ascorbic acid and of doing away with the possibility of acting as a catalyst only.

It is worth noting also that even a very low concentration of the condensation product (5 mgm. per 100 seeds) is much more effective than a much higher concentration of glucose (100 mgm. per 100 seeds), and the result with 25 mgm. per 100 seeds is as high as with 152 mgm. after 96 hr.

A sudden rise in vitamin C in case of glucose plus acetoacetate after 48 hr. may also be the result of formation of the condensation product through enzymatic processes during the course of germination.

Further details will be published elsewhere.

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Feb. 28.

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Permeability of Yolk of the Hen's Egg to Bromine-82

To investigate the resistance to diffusion between the two phases of the egg, the 34-hr. isotope of bromine (^{82}Br) as bromide was injected into the white in many eggs and its penetration into the yolk measured after various periods of time. About 5 ml. of the white of the egg to be injected was mixed with $\frac{1}{2}$ ml. of the radioactive bromide in isotonic solution, and injected as uniformly as possible throughout that remaining in the shell. The egg was maintained during the experimental period at 1° C., and, at its conclusion, frozen in a mixture of ether and dry ice. The yolk and white could then be separated cleanly with a sharp blow, and were conveniently diluted and their activities measured with a Geiger–Müller counter dipping into the liquids.

While the white was frozen, it was possible to scrape its entire inner surface, to collect the scrapings, and to analyse them separately. This showed that the activity of the layer in contact with the yolk was half that in the main mass of the white after 5–10 min., and that after 1 hr. there were no longer significant differences.

The rate of entry of the bromine-82 into the yolk was found to be constant between 5 and 200 hr., the longest experimental time which was practicable, when the activity reached, in the mean, 2·5 per cent of that in the white. This suggested that the penetration was across a single resistant barrier surrounding the yolk. That this was not the only obstacle was made evident when the distribution of the penetrating material within the yolk was studied. The superficial layer of the frozen yolk was sliced off, weighed, and analysed separately, and it was found that, even after 100 hr., one-third of the bromine-82 remained in the outermost 0·4 gm., corresponding to a thickness of about 0·1 mm. It is clear that after having passed the external resistant barrier, the ion still encounters an obstacle to its penetration into the yolk, and one is led to postulate a second barrier some tenths of a millimetre below the first; it is to be presumed that this system of spaced-out barriers would be repeated towards the centre of the yolk.

Before the fifth hour, the amount of bromine-82 found in the yolk is greater than that expected from the constant rate of entry found later. This excess of bromine-82 relative to its concentration in the layer of white in contact with the yolk, is markedly lower in the shortest experimental times, suggesting that it is not due to contamination of the yolk by the white during or after freezing, but rather to the penetration of the ion into an outer layer of yolk before the first resistant barrier is reached. As the vitelline membrane in the frozen egg invariably remained attached to the white, it would seem that this cannot be the resistant barrier in question.

A full account of the work will appear elsewhere.

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Single-spore Cultures of Heterothallic *Saccharomyces cerevisiæ* which mate with both the Tester Strains

Lindegren and Lindegren[1] observed that rare single-spore cultures produce abundant copulation tubes when the culture reaches full growth, and that the cells from these cultures can conjugate with the cells of any other culture irrespective of its being (+) or (−). They regarded this as a loss of discriminatory power due to a mutation of the gene producing copulation tubes.

During an investigation of the mating system in Danish baking yeast, *Saccharomyces cerevisiæ*, three such 'highly fertile' cultures were found. Each of them showed the formation of copulation tubes with both the tester strains. When original cultures were examined, abundant copulation tubes and zygotes were seen in each of them.

It was decided to isolate single cells and grow single-cell progenies, in order to see whether each cell belonging to these 'highly fertile' cultures had lost the power of discrimination and could mate with both the tester strains or not. Five cells with copula-

tion tubes and six ordinary vegetative cells were isolated from one of these cultures. Single-cell cultures were grown from them and tested for their mating capacity. As seen from the table, out of five cells with copulation tubes, four gave a (+) mating reaction and one a (−) reaction; likewise, of the six vegetative cells, one gave a (+) mating reaction and five a (−) reaction.

Nature of cells isolated	No. of cells isolated	No. of single cells showing a (+) mating reaction	No. of single cells showing a (−) mating reaction
Cells with copulation tubes	5	4	1
Vegetative cells	6	1	5

The facts that each of the single-cell progenies from the single-spore culture gives mating reaction with only one of the two tester strains, and that progenies from some cells prove to be (+) and from others (−), show that the mating responses of these stocks with both the tester strains were due, not to loss of mating discrimination, but to the creation of cells of opposite mating type within the culture through mutation[2]. The simultaneous existence of both types of cells in the culture results in the production of copulation tubes and zygotes in these stocks; and when they are tested with the tester strains, (+) cells in the culture produce copulation tubes on crossing with (−), and (−) cells on crossing with (+). This explanation seems more plausible than to assume the same cell on different occasions will respond to both as a result of loss of discriminatory power.

M. Ahmad

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University of Dacca,
Pakistan.
Feb. 26.

[1] Lindegren, C. C., and Lindegren, C., *Ann. Mo. Bot. Garden*, **31**, 203 (1944).
[2] Ahmad, M., Ph.D. thesis, Cambridge University (1948); *Annals of Botany* (in the press).

Edmond About and the Technique of Freezing and Drying Tissues

The procedure of freezing and drying tissues for the purposes of histology is commonly known as the Altmann or Altmann–Gersh method. Altmann published his method in 1890 [1], and Gersh, in 1932 [2], described fundamental improvements in the technique. It is curious that in 1862 the basic principles of the method were described in "L'homme à l'oreille cassée", a scientific romance by Edmond About, an English translation of which was available in 1867.

About describes how the frozen body of a French prisoner was carefully dehydrated *in vacuo* over sulphuric acid and calcium chloride and preserved by a German man of science during the Napoleonic Wars. The technical detail given by About is very plausible; he describes how the quality of the freezing was checked by observing the perfect preservation of the red blood cells. This is a test that I personally used before reading the book.

I have not been able to discover any information as to the extent of About's scientific training, and any suggestions as to the source of his ideas can be only speculation. The discovery of the technique of frozen sectioning is given by Mann[3] as 1842, and it is possible that About knew of this technique and improved on it for his story. It is also possible that he was elaborating the legends of bodies being recovered from glaciers.

It is a pleasing speculation to suggest that a German histologist may possibly have obtained the idea for a fundamental technique from reading a scientific romance.

I am indebted to Dr. Henri Firket for bringing the book to my notice.

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July 30.

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Terminology applied to Computing Machines

May I suggest that a protest is overdue against the anthropomorphic character of the terminology that is being applied to electronic digital computors? To the layman the use of such a terminology seems to ascribe human or near-human properties to these machines. Not only is it undesirable to use such terms, but also it is quite unnecessary, as alternative engineering terms are well established.

Those who describe electronic digital computors often use the term 'instruction', for example, when speaking of what is done to the machine by the operator. The word 'teaching' has even crept in. In engineering, the words 'setting' or 'adjustment' have exactly the same meaning. Why not use them? Numbers associated with these devices are given the name 'information' where the established term is 'readings'. Enthusiasts for electronic digital computors speak of the 'memory' of these machines; engineers would, instead, speak of 'records' or 'stores'. For the symbols that represent numbers in the mechanism, again, these enthusiasts have introduced the term 'machine language' where an engineer would say 'code'. Perhaps worst of all, a predetermined sequence of events in a digital electronic computor has been spoken of as a 'decision' of the machine.

Biologists and other men of science are careful to warn against anthropomorphic interpretations of animal behaviour. They avoid the word 'decision' when speaking of animals lest it convey to the lay public the suggestion that the animal's powers of volition resemble those rightly or wrongly assumed when the word is applied to human affairs. They are right, for many fallacies are rooted in anthropomorphic habits of thought. Is it wise, then, to encourage the lay public to believe that electronic digital computors possess rudimentary powers of scholarship, reasoning and volition, and that they may be thought about in a way that would be deprecated if applied to lower animals? There is abundant evidence that, aided by the new unfortunate terminology, such a notion is being spread. Hence this protest.

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Stanhope Road,
Croydon, Surrey.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Wednesday, October 1

Society of Public Analysts and Other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

British Kinematograph Society (joint meeting with the Television Society, at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1), at 7.15 p.m.—Dr. W. D. Wright: "The Viewing of Moving Pictures (Film and Television)".

Wednesday, October 1—Saturday, October 4

International Union of Nutritional Sciences (at Basle, Switzerland).—Symposium on "Present Problems in Nutritional Research".

Thursday, October 2

Aslib, Northern Branch (in the Council Chamber, Guildhall, Kingston-upon-Hull), at 11 a.m.—Conference.

Royal Aeronautical Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. R. E. Hardingham: "Maintaining Airworthiness in Operation" (Eighth British Commonwealth and Empire Lecture).

Friday, October 3

Association of Applied Biologists (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Papers on "Forestry Problems".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Scientific Officer and an Assistant Experimental Officer—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (October 6).

Assistant Lecturer in the Department of Geography (knowledge of cartography is desirable)—The Registrar, Queen Mary College, Mile End Road, London, E.1 (October 7).

Lecturer and an Assistant Lecturer in the Faculty of Education at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 10).

Senior Research Officer (with honours degree in physics or engineering, proven research ability, experience of length measurement and in handling of staff) in the Division of Metrology, National Standards Laboratory, New South Wales, to undertake research work in a well-equipped laboratory and to supervise work of the Length Section—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3984 (October 15).

Deputy Director of Research—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey (October 2).

Lecturer in Physics (with an honours degree and experience in research), and an Assistant Lecturer in Physics (with an honours degree: research experience would be an advantage), at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 20).

Assistant Lecturer in Mathematics at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 25).

Assistant Librarian and Library Assistants at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 30).

Lecturer (qualified either in mathematical statistics, or in pure or applied mathematics, but preferably with special knowledge of statistics) in the Department of Mathematics, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Lecturer in the Departments of Mathematics and Applied Mathematics, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Research Fellow (with a science degree of at least second-class honours and experience of ecological work in the field) to engage in fundamental research to determine the carrying capacity of the Hluhluwe Game Reserve, Zululand, in respect of certain animals, notably zebra and blue wildebeeste—The Secretary, Natal Parks, Game and Fish Preservation Board, P.O. Box 662, Pietermaritzburg, Natal, South Africa (October 31).

Director of Studies (with good academic qualifications and educational experience; university teaching experience would be an advantage) for the Royal Air Force College, Cranwell, to be responsible, under the Commandant, for directing and supervising the educational course in scientific, technical and humanistic subjects—The Air Ministry, S.2(o), Cornwall House, London, S.E.1.

Head of the Mathematics Department (with a good honours degree and good experience in teaching mathematics to advanced students of technical and university colleges)—The Registrar, Technical College, Sunderland, Co. Durham.

Junior Scientific Officer (male or female, with an honours degree in general science, pharmacy or biology) to undertake technical work in the Blood Transfusion Service Laboratory—The Director, Regional Transfusion Centre, Roby Street, Manchester 1.

Physicist (with honours degree) for work in Technological Department involving investigations into friction and measurement and control of yarn tension—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Scientific Officer and an Assistant (Scientific) in the Metropolitan Police Laboratory—The Secretary, Room 163, New Scotland Yard, London, S.W.1.

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Fitzwilliam Museum. Annual Report for the Year ending 31 December 1951. Pp. 9+4 plates. Friends of the Fitzwilliam Museum. Forty-third Annual Report for the Year 1951. Pp. 8. (Cambridge: Fitzwilliam Museum, 1952.) [266

Boulton, Watt and the Soho Undertakings. By W. K. V. Gale; with an Appendix by W. A. Seaby. Pp. v+40+10 plates. (Birmingham: Museum and Art Gallery, 1952.) 2s. 6d. [306

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Smithsonian Miscellaneous Collections. Vol. 117, No. 10: Periodicities in the Solar-Constant Measures. By C. G. Abbot. (Publication 4088.) Pp. ii+31. Vol. 117, No. 11: Important Interferences with Normals in Weather Records, associated with Sunspot Frequency. By C. G. Abbot. (Publication 4090.) Pp. ii+3. (Washington, D.C.: Smithsonian Institution, 1952.) [166

East African Tsetse and Trypanosomiasis Research and Reclamation Organization. Annual Report 1951. Pp. 56. (Nairobi: East African Tsetse and Trypanosomiasis Research and Reclamation Organization, 1952.) [166

Fiskeridirektoratets Skrifter, Serie Havundersøkelser. Vol. 9, No. 16: The Annual Phytoplankton Cycle of a Landlocked Fjord near Bergen (Nordåsvatn). By Trygve Braarud and Brigt Hope. Pp. 26. Vol. 10, No. 1: Faktorer av betydning for fiskeeggenes og fiskeyngelens oppveksy. Av Alf Dannevig og Sigfred Hansen. Pp. 36. (Bergen: A/s John Griegs Boktryckkeri, 1952.) [176

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United States Department of Commerce: Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12 and 24 Hours. Part 3: Florida. Pp. ii+92. (Washington, D.C.: Government Printing Office, 1952.) [176

A Demographic Study of the Eurasian Population in Rangoon in 1949. By John Clement Koop. Pp. iv+56. (Rangoon: Anglo-Burman Union, 1952.) [176

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